APPENDIX I
VOLUME I
Compilation of Attachments from Comment Letters on the Recirculated Draft EIR and Draft EIR

Appendix I contains comment letter attachments that are general and do not relate to specific sections of the DEIR or RDEIR. Therefore, no responses are provided. (Public Resources Code § 21091(d); CEQA Guidelines § 15204(a)) Responses to comments and attachments requiring responses can be found in FEIR Chapter 2.

Attachments from Comment Letter R32

Attachment (A) to Oct 18, 2012 PCAC EIR Subcommittee Comments on Recirculated SCIG DEIR

HEALTH EFFECTS OF DIESEL EXHAUST AIR POLLUTION

August 28, 2003

Document prepared by the Environmental Subcommittee/Air Quality Group to be forwarded to the Board of Harbor Commissioners (BOHC) via PCAC

Subject: Committees Findings Regarding Health Effects of Diesel Exhaust Air Pollution; with Concern for Port Activity Related Sources

BACKGROUND: Since its inception the Environmental Subcommittee has been considering the issue of the multiple health effects that have been associated with diesel exhaust air pollution. Experts hired by the Committee, including Professor Avol, Mr. Howekamp, and experts from ARB and AQMD have frequently provided input. These experts also found data for the committee's review from sources they had available. Dr. John G. Miller, an Environmental Sub-committee member and PCAC member cited and provided multiple references from the medical, epidemiologic and scientific literature on this topic. Members of the public have expressed concerns at many committee meetings.

The committee has learned that the Health Risk Assessment Study (HRA) to be completed by consultants hired by the POLA, as one of the Seven Studies mandated by the BOHC, is not scheduled to begin until possibly January 2004, depending on when the (as yet incomplete) Air Emissions Inventory is finished. The completion date for the HRA is currently estimated to be late 2004/early 2005.

Environmental Sub-committee members have heard extensive input from the public requesting no further delay in conveying what it has found to date to the BOHC. This input came both at meetings and in the community. The committee finds no reason for further delay in revealing its findings to date.

The committee notes that Port-related activities, including those that occur off Port property but as a result of Port operations, have been identified by the South Coast AQMD as the largest single unregulated contributor to area-wide air pollution.

Port operations (shipping, loading/unloading, and transport of product) require the use of significant amounts of fuel. Currently most of the trucking, locomotive, and off-road yard operations in and supporting the Port use diesel fuel. The combustion of diesel fuel creates high concentrations of very small particles (numerically, over 90% are less than 1 micron in diameter) and nitrogen oxides. Regional air studies have demonstrated that Port-related emissions are transported widely in the air across the South Coast Air Basin, from the harbor area to Riverside/San Bernardino and beyond. These pollutants have been associated directly (through direct exposure by breathing these pollutants from the air) and indirectly (through participation in photochemical reactions in the air, and breathing the products of these reactions, such as ozone) with a number of health effects.

The Sub-committee has learned that some of these health effects occur even when concentrations of particulates are just one quarter of the Federal limit for outdoor air.

Summary of Health Effects that have been related to Diesel Exhaust Air Pollution as identified and brought to the committee's attention:

1. Prenatal and Perinatal effects
    A. Intrauterine growth retardation
    B. Elevated incidence of low birth weight infants
    C. Increased incidence of spontaneous miscarriage
    D. Increased incidence of respiratory cause of deaths in newborns
    E. Elevated incidence of serious birth defects
    F. Increases in sudden infant death syndrome (SIDS)

2. Childhood effects
    A. Diminished lung growth in children (with unknown long term effects on the individual)
    B. Development of asthma in children involved in active sports
    C. Exacerbations of existing asthma
    D. Elevation of incidence of asthma in children and teenagers. (an ongoing worldwide phenomenon)
    E. Increases in incidence of bronchitic symptoms
    F. Loss of days from school attendance due to respiratory symptoms
    G. Potentiation (enhancement) of allergic effects of known allergens such as ragweed pollen when individual is exposed to diesel particles and the allergen concomitantly.

3. Adulthood
    A. Elevated incidence of lung cancer in a linear relationship with progressive increases in fine particle (Pm 2.5) air pollution (The category Pm 2.5 includes the particles less than 1 micron in size.)
    B. Elevated incidence of myocardial infarctions (heart attacks)
    C. Elevated incidence of mortality from cardiovascular causes (heart attacks and strokes)
    D Triggering of myocardial infarctions associated with spikes in Pm 2.5
    E Elevation of cardiopulmonary deaths in a linear relationship with increases in Pm 2.5
    F. Significant elevations in "all cause mortality" associated with increases in Pm2.5
    G. Increased incidence of bronchitic symptoms
    H. Chronic obstructive pulmonary disease (COPD): increased incidence, prevalence, and exacerbations of existing disease.
    I. Fatal exacerbations of COPD
    J. Exacerbations of asthma leading to time off work, emergency room visits and hospitalizations

K. Approximately 1.5 times elevation in the smoking adjusted incidence of lung cancer in workers occupationally exposed to diesel exhaust versus the smoking adjusted relative risk baseline incidence of lung cancer in similar non-exposed populations.
L. Chronic exposure to particulate pollution shortens lives by one to three years
M. Higher concentrations of particulate air pollution has been linked to low heart rate variability, a risk factor for heart attacks. Association is stronger for people with pre-existing cardiovascular conditions.
N. Mitochondrial damage in cells. (All age groups)
O. Airway inflammatory changes (all age groups)
P. Damage to and death of alveolar and airway macrophages,(all age groups)

This is a brief overview of an extensive and growing body of knowledge. These findings were developed through many avenues of research including but not limited to: epidemiologic studies, clinical studies-retrospective and prospective, autopsy studies, animal studies, cellular biology studies, and Government agency investigations. There has been worldwide scientific participation in research on the links between diesel exhaust air pollution and human health.

This body of knowledge is constantly evolving, with many new pieces of information having been published or brought to light since the inception of Environmental Committee Subcommittee/Air Quality Group. The committee notes that as this an evolving body of knowledge, in many areas further studies are needed.

The Committee finds sufficient evidence to warrant immediate aggressive action by POLA and its tenants to reduce the measurable levels of local and Air Basin wide diesel exhaust air pollution due to Port related activities.

Richard Havenick
Chairman, Air Quality Group

References Regarding the Health Effects of Diesel Exhaust Air Pollution
July 25, 2003

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10. Editorial "Air Pollution Kills Babies…" Epidemiology, November 1999, Volume 10, number 6.

11. "Ambient Air Pollution and the Risks of Birth Defects in Southern California" American Journal of Epidemiology, Volume 155, Number 1, 2002. (Research done at UCLA).

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14. "The Effects of Ambient Air Pollution on School Absenteeism due to Respiratory Illnesses" Epidemiology, January 2001, Volume 12, Number1. (Research done at USC).

15. "Air Pollution and Infant Mortality in Mexico City" Epidemiology, March 1999, Volume 10, Number 2.

16. "Air Pollution and Bronchitic Symptoms in Southern California Children with Asthma" Environmental health Perspectives, Volume107, Number 9, September 1999.

17. "Association between Air Pollution and Lung Function Growth in Southern California Children" American Journal of Respiratory and Critical Care Medicine, Volume 162, 2000.

18. "Global Increases in Allergic Respiratory Disease: The Possible Role of Diesel Exhaust Particles" Annals of Allergy, Asthma and Immunology, Volume 77, October 1996. (Research done at UCLA).

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Attachments from Comment Letter R80

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Losing life and livelihood: A systematic review and meta-analysis of unemployment and all-cause mortality

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ABSTRACT

Unemployment rates in the United States remain near a 25-year high and global unemployment is rising. Previous studies have shown that unemployed persons have an increased risk of death, but the magnitude of the risk and moderating factors have not been explored. The study is a random effects meta-analysis and meta-regression designed to assess the association between unemployment and all-cause mortality among working-age persons. We extracted 235 mortality risk estimates from 42 studies, providing data on more than 20 million persons. The mean hazard ratio (HR) for mortality was 1.63 among HRs adjusted for age and additional covariates. The mean effect was higher for men than for women. Unemployment was associated with an increased mortality risk for those in their early and middle careers, but less for those in their late career. The risk of death was highest during the first 10 years of follow-up, but decreased subsequently. The mean HR was 24% lower among the subset of studies controlling for health-related behaviors. Public health initiatives could target unemployed persons for more aggressive cardiovascular screening and interventions aimed at reducing risk-taking behaviors.

According to the United States Department of Labor, the US unemployment rate was 9.6% in August 2010 (compared to 5.8% in July 2008), remaining near its highest level in 25 years (United States Department of Labor, 2010). As of July 2010, the unemployment rate was 7.1% in Canada, 5.3% in Australia, 4.9% in Japan, 9.6% in France, 7.3% in Germany, 8.5% in Italy, 4.4% (June 2010) in the Netherlands, 8.4% in Sweden, and 7.8% (May 2010) in the United Kingdom (U.S. Bureau of Labor Statistics, 2010). Even before the 2008–2009 economic crisis, the United Nations International Labor Organization estimated that unemployment had reached a historical high in 2006 (United Nations News Centre, 2007). The *London Times* estimated that, as a result of the current economic crisis, the number of unemployed worldwide could climb further, from 179 million in 2007 to 230 million (Mortished, 2009). This recent rise makes understanding the health effects of unemployment particularly important.

Over the last 4 decades the study of unemployment and its association with health and mortality has expanded significantly (see Hanisch, 1999 for an early comprehensive review on unemployment research). Whether unemployment is causally related to mortality remains an open question (Janlert, 1997; Lundin, Lundberg, Hallsten, Ottoson, & Hemmingsson, 2010; Martikainen, 1990; Martikainen, Maki, & Jantti, 2007; Moser, Goldblatt, Fox, & Jones, 1987), and recent research has begun to focus on possible confounding, mediating, and moderating factors.

One important line of research has been exploring the role of health behaviors such as smoking and alcohol consumption on unemployment and health. This research has generated two major hypotheses regarding the relationship between unemployment and health behaviors. The first, the "coping hypothesis", argues that unemployment causes adverse changes in health behaviors, which in turn lead to deterioration of health (e.g. Hammarstrom, 1994). The second, a "latent sickness hypothesis", suggests that the unemployment-mortality association is spurious because pre-existing health behaviors lead to both unemployment and adverse health (e.g. Jusot, Khlat, Rochereau, & Sermet, 2008).

A second important line of research explores the role of macro-level economic factors in the unemployment-health relationship. National welfare and unemployment policies are thought to play a moderating role, with the negative effects of unemployment being substantially reduced in nations with more generous financial support systems (Bambra & Eikemo, 2009; Gerdtham & Ruhm, 2006;

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Jantti, Martikainen, & Valkonen, 2000; Stuckler, Basu, Suhrcke, Coutts, & McKee, 2009). In addition, some researchers have focused on regional and national unemployment rates as a moderator, finding harsher personal unemployment effects when there are relatively few others who are also unemployed (Gerdtham & Johannesson, 2005; Martikainen et al., 2007; Martikainen & Valkonen, 1996; Novo, Hammarstrom, & Janlert, 2001). Others have reported a seemingly paradoxical relationship, noting that dangerous health behaviors decline when the unemployment rate is high (e.g. Ruhm, 2000).

Despite its extensiveness, only one systematic review of the unemployment literature has been conducted (see Jin, Shah, & Svoboda, 1995). This review, however, was qualitative in nature and examined multiple health outcomes. A systematic, quantitative review of the association between unemployment and mortality, arguably the most important outcome, has not yet been conducted. While most studies found that unemployment is associated with decreased longevity, there is no consensus on the magnitude of the association for any sub-group population, and reported relative risks range from 0.68 to 4.83. Furthermore, there is little consensus with respect to which of the possible mediating, moderating, and confounding variables matter most. Meta-analysis is well suited to address this important research problem. Ample cross-study variability now exists to analyze sub-groups and to assess the effects of potential confounding, mediating, and moderating variables.

Mediating and confounding health factors in unemployment research

Early work on the association between unemployment and mortality suggested that the relationship is causal (Moser et al., 1987). More recent work, however, has called this into question and the issue of causation remains unsettled (Martikainen, 1990; Martikainen et al., 2007). Many studies, for example, have documented that persons with pre-existing health conditions are more likely to become and remain unemployed (Bartley & Owen, 1996; Bockerman & Ilmakunnas, 2009; Claussen, 1993; Salm, 2009). Browning, Moller-Dano, and Heinesen (2006) also reported that unemployment did not lead to hospitalization for stress-related diseases. While it has also been found that persons with health problems fare better in the long-run if they maintain or regain employment (Bartley, Sacker, & Clarke, 2004; Huber, Lechner, & Wunsch, 2010), this body of work suggests that pre-existing health may be a common cause of both unemployment and mortality.

Yet many studies continue to find an association between unemployment and mortality even after controlling for pre-existing health status. Whether these provide evidence of a causal link is still uncertain, and much of the debate over causation vs. spurious association has focused on health behavior variables. Unfortunately, the vast majority of individual-level studies of unemployment and health behaviors is cross-sectional and cannot be used to adjudicate between these two hypotheses. Furthermore, many of the macro-level studies of unemployment rates and aggregate health behavior measures cannot be used as they lack individual-level data on health behaviors, health outcomes, and employment status (Catalano & Bellows, 2005). We therefore focus the review below on studies with individual-level data.

The latent sickness hypothesis

Many researchers continue to argue that the unemployment-mortality association is spurious. These scholars argue that health selection into unemployment operates through health behavior variables rather than in a direct manner (i.e. the “latent sickness hypothesis”) (Jusot et al., 2008). For example, if the health problems associated with high levels of drug, alcohol, and tobacco consumption manifest themselves only after the onset of unemployment, controlling for pre-existing health status would not effectively rule out health selection. In support of this view, studies have shown repeatedly that individuals with higher levels of smoking, drinking, and recreational drug use are more likely to become unemployed (Fergusson & Boden, 2008; Hammer, 1997; Hoffmann, Dufur, & Huang, 2007; Leino-Arjas, Liira, Mutanen, Malmivaara, & Matikainen, 1999; Montgomery, Bartley, Cook, & Wadsworth, 1996; Morris, Cook, & Shaper, 1992).

The latent sickness hypothesis is also supported, indirectly, by evidence that the income reduction associated with unemployment actually leads to positive changes in health behaviors (see Temple et al., 1991). Reduced drinking and smoking have been found among the long term unemployed (Fagan, Shavers, Lawrence, Gibson, & Ponder, 2007; Hammer, 1992; Liira & Leino-Arjas, 1999). Furthermore, improved physical activity levels have been found among the recently unemployed (Jurj et al., 2007; Matoba, Ishitake, & Noguchi, 2003). Other studies have found no change in health behaviors, either positive or negative, resulting from unemployment (Gallo, Bradley, Siegel, & Kasl, 2001; Goel, 2008; Iribarria, Ruiz, Pardo, & San Martin, 2002; Peretti-Watel & Constance, 2009; Rehm & Gmel, 1999; Rodriguez & Chandra, 2006; Virtanen et al., 2008).

The coping hypothesis

Other researchers, however, continue to argue for causation, claiming that health behavior variables actually represent an important mediating mechanism through which unemployment is translated into mortality (i.e. the “coping hypothesis”). According to this view, individuals cope with unemployment stress by changing their consumption patterns in unhealthy ways (Hammarstrom, 1994; Laitinen, Ek, & Sovio, 2002; Viinamaki, Niskanen, & Koskela, 1997), particularly individuals with low socioeconomic status prior to the onset of unemployment (Kendzor et al., 2008) and younger persons (Morrell, Taylor, & Kerr, 1998). Individuals with low social status are thought to be particularly prone to negative coping because they feel that this type of stress-relief is all they have left (Peretti-Watel & Constance, 2009).

A large body of work supports the coping hypothesis. First, multiple studies have found that alcohol consumption and binge drinking rise following unemployment (Claussen, 1999). This is especially true among men (Hammarstrom & Janlert, 2003; Mossakowski, 2008; Virtanen et al., 2008), less educated people (Broman, Hamilton, Hoffmann, & Mavaddat, 1995), young persons (Janlert & Hammarstrom, 1992), and those involuntarily unemployed (Ettner, 1997). Second, unemployed persons, especially young men, are also more likely to increase their level of smoking (Barnes & Smith, 2009; Bolton & Rodriguez, 2009; Falba, Teng, Sindelar, & Gallo, 2005; Hammarstrom & Janlert, 1994, 2003; Montgomery, Cook, Bartley, & Wadsworth, 1998; Reine, Novo, & Hammarstrom, 2004). Unemployed smokers are less likely to attempt smoking cessation (Weden, Astone, & Bishai, 2006) and are more likely to relapse from smoking cessation efforts (Falba et al., 2005). Finally, unemployed persons are more likely to increase their use of illicit drugs (Alegria et al., 2004; Hammer, 1992; Merline, O'Malley, Schulenberg, Bachman, & Johnston, 2004) or begin using drugs (Crofts, Louie, Rosenthal, & Jolley, 1996; Green, Doherty, Reisinger, Chilcoat, & Ensminger, 2010).

Negative health consequences may also arise through the tendency of people to react to unemployment by reducing their personal spending. Research has shown that unemployed persons often substitute poorer quality diets for better ones. This may result in obesity (Laitinen, Power, Ek, Sovio, & Jarvelin, 2002), or in unhealthy weight loss (Bolton & Rodriguez, 2009). Some have even found that the threat of unemployment alone was enough to cause increased body mass index (BMI) (Ferrie, Shipley, Marmot, Stansfeld, & Smith, 1998). Once unemployed, increased BMI creates a feedback loop, as those who are judged as overweight have difficulties in finding work (Johansson, Bockerman, Kiiskinen, & Heliovaara, 2009; Paraponaris, Saliba, & Ventelou, 2005) and increased BMI may therefore lead to permanent labor force withdrawal (Alavinia & Burdorf, 2008).

The present study seeks to assess the impact of potential mediating, moderating, and confounding factors on the association between unemployment status and mortality. First, we evaluate the impact of pre-existing health status and health behaviors, variables that are central to the current debates in the literature. Using meta-analysis, we compare results from studies that controlled for health and/or health behaviors with other studies that did not. Second, in light of the literature on the potential moderating effects of national health care systems, we compare study results between countries with national health care systems and those without. Finally, we assess the potential moderating roles of gender, age, time, follow-up duration, and case/control group composition on the unemployment-mortality association. In each instance, we capitalize on cross-study variability to assess the impact of key factors. Becoming unemployed may also have a mediated effect on health due to the psychosocial stress of being forced into a lower social status (Fineman, 1979; Martikainen & Valkonen, 1996), but this mediating factor is often assumed rather than empirically examined, and is therefore beyond the scope of the present study.

Methods

Search strategy and coding procedures

In June 2005, we conducted a search of electronic bibliographic databases to retrieve all publications combining the concepts of psychosocial stress, including unemployment, and all-cause mortality. We re-ran the electronic keyword searches in these databases in July 2008 and completed the search and coding stages in January 2009. We used 100 search clauses for Medline, 97 for EMBASE, 81 for CINAHL, and 20 for Web of Science. See Section 1 of Appendix for the full search algorithm used for Medline (information on the remaining search algorithms are available from authors upon request). We identified 1570 unique publications. Using these results as a base, we iteratively hand-searched the bibliographies of eligible publications; the lists of sources citing an eligible publication; and the sources identified as “similar to” an eligible publication. Hand-searching was ongoing for three and one-half years and was completed after 8 iterations (the full description of this iterative search protocol is documented and available from the authors upon request).

The electronic database searches were performed by a research librarian. Two authors (DR and ES) trained in systematic review coding procedures (Lipsey & Wilson, 2001; Stock, 1994) determined publication eligibility and extracted the data from the articles, consulting a third author (JS) when required (see Section 2 of Appendix for additional details regarding coding procedures and variables for which data were sought). Any unpublished work encountered was considered for study inclusion. Although our search was done in English, we were able to locate and translate the relevant portions of 35 publications written in German, Danish, French, Spanish, Dutch, Polish, or Japanese. Fig. 1 summarizes the number of publications considered at each step of the search process. The full database contains 262 publications examining the associations between various stressful events and all-cause mortality. To evaluate coding accuracy we randomly selected and recoded 40 of these publications (including 446 point estimates). Of the point estimates, 98.6% were free of coding errors.

The present analysis uses the subset of articles ($n = 42$) that reported the association between unemployment and all-cause mortality. Forty of these publications appeared in peer-reviewed

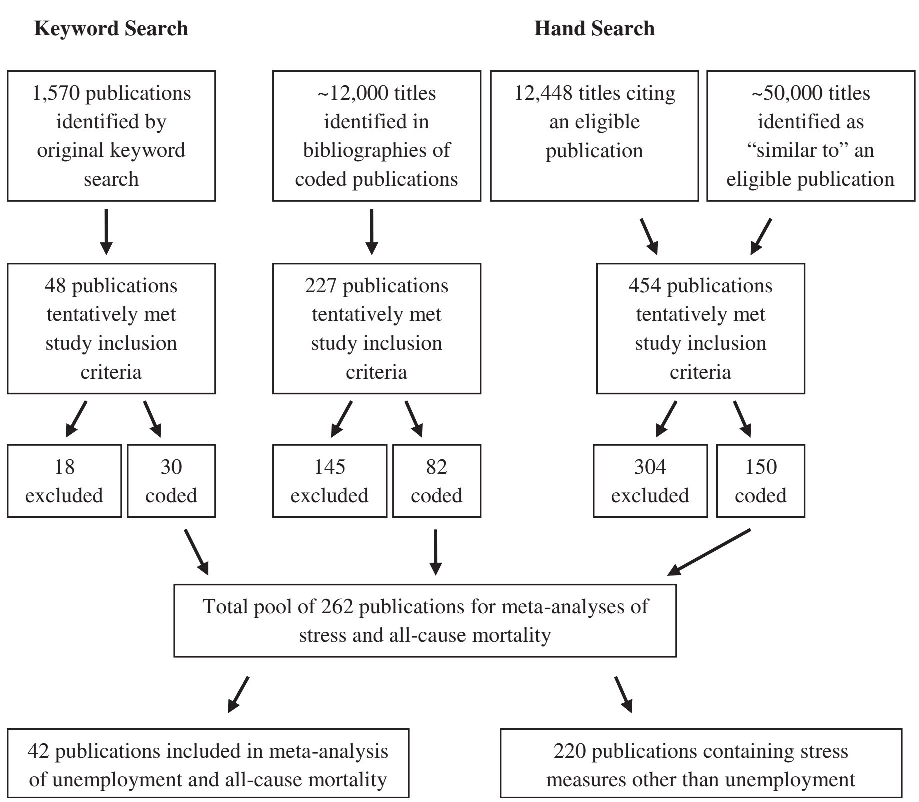


Fig. 1. Flow diagram.

Table 1
Studies included in the analyses.

Publication	Data source	Sample size	Years	Unemployment measure used	Comparison group	Average HR[a]	No. of HRs	No. of HRs controlling for:		
								Health (any)	Health behaviors	SES (any)
Ahs and Westerling (2006)	Swedish Survey of Living Conditions	44,407	1984–2000	Unemployment	Employed	1.28	6	3	0	3
Anson (2004)	Census, 1991 (Belgium)	391,299	1991–1996	Not working[b]	Employed	1.88	6	0	0	6
Blakely et al. (2006)	Census, 1996 (New Zealand)	2,676,000	1996–1999	Unemployment	Employed	1.23	2	0	0	2
Costa and Segnan (1987)	Census, 1981 (Italy)	1,117,154	1981–1985	Unemployment	Employed	2.61	2	0	0	0
Farmer et al. (1996)	Corpus Christi Heart Project (U.S.)	596	1988–1992	Not working	Employed	2.17	3	3	3	0
Gardner and Oswald (2004)	British Household Panel Survey	3695	1991–2001	Unemployment	Employed	1.00	4	2	2	4
Gerdtham and Johannesson (2003)	Swedish Survey of Living Conditions	27,994	1980–1996	Unemployment	Employed	7.20	2	1	0	1
Gognalons-Nicolet, Derriennic, Monfort, and Cassou (1999)	Office of Geneva Residents (Switzerland)	820	1984–1996	Unemployment	Employed	3.30	2	2	0	2
Helweg-Larsen, Kjoller, and Thoning (2003)	Danish National Cohort Study	6693	1987–1999	Not working	Employed	1.42	1	1	1	0
Herring, Bonilla-Carrión, Borland, and Hill (2008)	Census, 2000 (Costa Rica)	3,744,486	2000–2005	Unemployment	Employed	1.07	2	0	0	2
Hirokawa, Tsutusmi, and Kayaba (2006)	Jichi Medical School Cohort Study (Japan)	11,081	1992–2002	Not working	Employed	1.45	18	6	6	6
Iversen et al. (1987)	Census, 1970 (Denmark)	2,006,774	1970–1980	Unemployment	Employed	1.57	8	0	0	0
Jenkinson, Madeley, Mitchell, and Turner (1993)	Anglo-Scandinavian Study of Early Thrombolysis (U. K.)	1376	1986–1990	Unemployment	Employed	1.84	3	0	0	0
Johnson, Finney, and Moos (2005)	Original data (U.S.)	3698	5 years	Not working	Employed	1.53	2	2	2	0
Kivimaki et al. (2003)	10-Town Study (Finland)	92,351	1990–2001	Unemployment	Employed	2.02	4	0	0	2
Lavis (1998)	Panel Study of Income Dynamics (U.S.)	5544	1968–1992	Unemployment	Employed	2.26	8	0	0	8
Manor, Eisenbach, Peritz, and Friedlander (1999)	Israel Longitudinal Mortality Study	72,527	1983–1992	Not working	Employed	1.85	2	0	0	1
Manor, Eisenbach, Israeli, and Friedlander (2000)	Israel Longitudinal Mortality Study	79,623	1983–1992	Not working	Employed	1.43	2	0	0	1
Martikainen (1990)	Census, 1980 (Finland)	4,779,535	1980–1985	Unemployment	Employed	2.17	2	1	0	1
Martikainen and Valkonen (1996)	Census, 1990 (Finland)	2,500,000	1987–1993	Unemployment	Employed	2.28	30	0	0	22
Martikainen et al. (2007)	Statistics Finland labor market data file	159,736	1994–2002 1989–1997	Unemployment	Employed	1.25	12	0	0	0
Masudomi, Isse, Uchiyama, and Watanabe (2004)	Original data (Japan)	375	1994–1999	Unemployment	Employed	4.12	2	1	0	0
Morrell, Taylor, Quine, Kerr, and Western (1999)	Australian Longitudinal Survey	5997	1984–1988	Unemployment	General popul.	2.81	5	3	0	3
Morris, Cook, and Shaper (1994)	British Regional Heart Study	6191	1978–1990	Unemployment	Employed	2.37	3	1	1	1
Moser et al. (1984)	OPCS Longitudinal Study (U.K.)	161,699	1971–1981	Unemployment	General popul.	1.27	4	0	0	2
Moser et al. (1986)	OPCS Longitudinal Study (U.K.)	161,699	1971–1981	Unemployment	General popul.	1.28	4	0	0	0
Moser et al. (1987)	OPCS Longitudinal Study (U.K.)	161,699	1971–1981	Unemployment	General popul.	1.26	5	0	0	0
Nylen, Voss, and Floderus (2001)	Swedish Twin Registry	20,632	1973–1996	Unemployment	Employed	2.13	16	8	8	0
Orth-Gomer, Johnson, Unden, and Edwards (1986)	Swedish Survey of Living Conditions	17,364	1976–1981	Not working	Employed	1.59	1	1	0	1
Palloni and Arias (2004)	National Health Interview Survey (U.S.)	39,014	1986–1997	Unemployment	Employed	1.24	2	0	0	2
Pensola and Martikainen (2003)	Census, 1990 (Finland)	123,216	1990–1998	Unemployment	Employed	2.31	2	0	0	0
Pensola and Martikainen (2004)	Census, 1990 (Finland)	186,408	1990–1998	Unemployment	Employed	2.72	6	0	0	2
Regidor, Calle, Dominguez, and Navarro (2001) [c]	Census, 1996 (Spain)	3,110,121	1996–1998	Not working	Employed	2.05	8	0	0	4
Robinson, Lloyd, and Stevens (1998)	Original data (U.K.)	2104	1985–1997	Unemployment	Employed	2.48	4	2	0	2
Singh and Siahpush (2001)	National Longitudinal Mortality Study (U.S.)	301,183	1979–1989	Not Working	Employed	4.63	6	0	0	3
Sorlie and Rogot (1990)	National Longitudinal Mortality Study (U.S.)	452,192	1979–1983	Unemployment	General popul.	1.10	10	0	0	2
Sorlie, Backlund, and Keller (1995)	National Longitudinal Mortality Study (U.S.)	530,507	1979–1989	Unemployment	Employed	1.19	12	0	0	6
Spence (2006) [d]	National Longitudinal Survey of Mature Women (U.S.)	3258	1967–2001	Unemployment	Employed	1.61	1	1	0	1
Stefansson (1991)	Swedish Survey of Living Conditions	47,701	1980–1986	Unemployment	Employed	1.77	6	0	0	0
Tsai, Lan, Lee, Huang, and Chou (2004)	National health insurance and unemployment insurance programs (Taiwan)	185,162	2001–2002	Unemployment	Employed	1.96	3	3	0	3
Voss, Nylen, Floderus, Diderichsen, and Terry (2004)	Swedish Twin Registry	20,632	1973–1996	Unemployment	Employed	1.44	12	4	4	0
Weitoft, Haglund, and Rosen (2000)	Census, 1990 (Sweden)	712,479	1990–1995	Unemployment	Employed	0.83	2	0	0	0

Abbreviations: HR, hazard ratio; OPCS, Office of Population Censuses and Surveys.
[a] Average HRs were obtained by calculating the unweighted average of all mortality risk estimates for a given study after conversion into HRs.
[b] Denotes a combination of unemployed persons and those not in the labor force.
[c] Original publication in Spanish.
[d] Unpublished dissertation.

journals; 1 in a book chapter; and 1 in an unpublished dissertation. One publication was translated from Spanish in consultation with a native speaker; the remaining 41 publications were in English (Table 1). Other subsets of the database of 262 publications were used to produce analyses of war-related stress (Roelfs, Shor, Davidson, & Schwartz, 2010), widowhood (Roelfs, Shor, Curreli, Clemow, Burg, & Schwartz, in press), marital dissolution (Shor, Roelfs, Bugyi, & Schwartz, unpublished), and other psychosocial stressors.

Statistical methods and inclusion criteria

For the present analyses, a study was included if the outcome variable was all-cause mortality, unemployment was measured at the individual level (rather than at the neighborhood level), and a clear comparison was made between a group of people who experienced unemployment and another group who either did not experience unemployment at all or experienced it to a lesser degree. As shown in Table 1, most studies compared unemployed persons with employed persons, while a few compared unemployed persons with the general population. We examined whether this distinction affected the estimated association between unemployment and mortality.

Statistical methods varied from study to study, necessitating the conversion of odds ratios, rate ratios, standardized mortality ratios, relative risks, and hazard ratios (HRs) into a common metric (See Section 3 of Appendix). For 63 of the 235 measures of mortality risk, the death rate information required for conversion to a common metric was not reported. In these cases, the required death rate was estimated using multiple regression analysis (see Section 4 of Appendix). Sensitivity analyses were performed to examine the possible effect of including or excluding studies for which an estimated death rate was used in the conversion to a common metric.

As is standard practice, we used the standard errors reported in the publications to calculate the inverse variance weights (See Section 5 of Appendix). When not reported, standard errors were calculated using (1) confidence intervals, (2) t statistics, (3) χ^2 statistics, or (4) p-values. When upper-limit p-values were the only estimate of statistical significance available (e.g. in cases where we knew only that the p-value lay somewhere between 0.01 and 0.05), the midpoint of the upper and lower limits was used to estimate the p-value. In 24 cases, no measure of statistical significance was reported and standard errors were estimated using multiple regression (See Section 4 of Appendix). An indicator variable was created so analyses could be conducted both with and without data points where the standard error was estimated.

Quality was assessed using the Newcastle-Ottawa scale for nonrandomized trials (Wells et al., 2009). Two authors (DR and ES) also independently rated each publication, the average from these two ratings being used in the analysis.

Q-tests, I^2 tests, and examinations of the unexplained heterogeneity variance component were used to assess the presence and magnitude of heterogeneity in the data (Huedo-Medina, Sanchez-Meca, & Marin-Martinez, 2006). Q-test results from preliminary analyses revealed substantial heterogeneity across studies' effect sizes. In light of this all meta-analyses and meta-regression analyses were calculated by maximum likelihood using a random effects model and sensitivity analyses were conducted using the variables identified by the meta-regression models as significant sources of heterogeneity. Analysis was performed with statistical software (PASW, version 18.0) using matrix macros provided by Lipsey and Wilson (2001). The possibility of selection and publication bias was examined using a funnel plot of the log HRs against sample size. Funnel plot asymmetry was tested using Egger's test (Egger & Davey-Smith, 1998). Due to the heterogeneity in the data, funnel plot asymmetry was also tested using weighted least squares regressions of the log HRs on the inverse of the sample size (Moreno et al., 2009; Peters, Sutton, Jones, Abrams, & Rushton, 2006).

Analyses performed include meta-analyses of sub-groups, bivariate meta-regression analyses, and multivariate meta-regression analyses. The covariates used in the analyses were dictated by data availability. Variables such as race or ethnicity, which were used as grouping variables or included in interaction terms in only a small number of studies, could not be used in the analyses. Likewise, variables summarizing the prevalence of smoking or drinking, and other health behavior variables that would have been useful for additional analyses of confounding, were not reported and could therefore not be examined. The following independent variables were used in these analyses: (1) whether death rate was estimated (yes or no); (2) whether standard error was estimated (yes or no); (3) proportion of respondents who were male; (4) mean age of sample at baseline; (5) age of the study (i.e. years elapsed since the beginning of baseline), divided by 10; (6) time elapsed between the end of baseline and the beginning of follow-up; (7) maximum follow-up duration; (8) type of comparison group; (9) geographic region; (10) sample size, log transformed; (11) Newcastle-Ottawa Scale rating (range, 0–9); and (12) a series of variables indicating whether sex, age, socioeconomic status, and health were statistically controlled.

Results

Table 1 provides summary information on the 42 publications included in this study. This table is presented in lieu of the standard meta-analysis forest plot because of space limitations and the inherent difficulty in garnering data heterogeneity information from a plot that contains 235 point estimates and confidence intervals. The mean relative risk from each of the 42 publications, however, was included in Table 1 in the interest of providing information from which some heterogeneity observations might be made. The forest plot is available from the authors on request.

Table 2 provides descriptive statistics on the 235 mortality risk estimates included in this study. Data were obtained from 42 studies, published between 1984 and 2008, covering 15 countries (mostly in Europe and North America), and representing more than 20 million persons. The majority of persons analyzed were men, and almost all were of working-age at baseline. The average follow-up duration across all studies was 9.02 years. Of the HRs analyzed, the mean 5-year impact factor was 5.59 and the mean number of citations received per year since publication was 2.68. The mean score on the Newcastle-Ottawa Scale was 7.76.

Table 3 presents the results of a number of meta-analyses (See Table 4 for sample size information). All analyses were stratified by the level of statistical adjustment of the risk estimate. Persons who experienced unemployment were significantly more likely to die than the comparison group. The mean unadjusted HR was 2.08 (95% confidence interval [CI], 1.77–2.43; $n = 40$ risk estimates); age-adjusted HR, 1.59 (95% CI, 1.42–1.77; $n = 75$); and HR adjusted for age and additional covariates, 1.63 (95% CI, 1.49–1.79; $n = 120$). These results show that unemployment is associated with a 63% higher risk of mortality in studies controlling for covariates. Table 3 also shows that the exclusion of data where either the death rate or the standard error had to be estimated does not alter the direction, magnitude, or level of statistical significance of the mean HRs.

sub-group meta-analyses and meta-regression analyses

As described at the end of the methods section, data on the prevalence of high BMI, smoking, drinking, drug use, or other

Table 2
Distribution of mortality risk estimates in the analysis by selected variables.

Variable	Distribution[a]
Publication date	
1980–1989	10.2
1990–1999	38.3
2000–2008	51.5
Level of statistical adjustment	
Unadjusted	17.0
Adjusted for age only	31.9
Adjusted for age and additional covariates	51.1
Sex	
Women only	33.6
Men only	47.2
Both	19.2
Mean age of study sample at baseline (y)	
<40	31.5
40–49.9	51.5
50–64.9	14.4
≥65	2.6
Baseline start year	
1960–1969	2.1
1970–1979	35.7
1980–1989	33.4
1990–2001	28.8
Years elapsed between end of baseline and start of follow-up	
0	80.4
>0	19.6
Comparison group	
Employed only	91.1
General population	8.9
Nation	
Denmark, Finland, and Sweden	46.7
United States	18.7
United Kingdom	11.5
Japan and Taiwan	9.8
Belgium, Italy, Israel, Spain, and Switzerland	9.5
Australia and New Zealand	3.0
Costa Rica	0.9
Maximum follow-up time (y): first quartile	5.0
Median	8.0
Third quartile	10.5
Death rate estimated?	
Yes	26.8
No	73.2
Standard error estimated?	
Yes	10.2
No	89.8
Mean Newcastle-Ottawa scale rating	7.76

[a] Values are percentages unless indicated otherwise, $n = 235$ hazard ratios.

health factors was not available for analysis. However, comparisons between the subset of our data where health was directly controlled ($n = 45$ HRs) or where health-related behaviors were controlled ($n = 27$ HRs) and the remaining data still provides results relevant to the debate between the coping hypothesis and the latent sickness hypothesis. Table 5 presents the results of the meta-regression analyses, which provide a multivariate test for differences between key sub-groups. Model 1 shows that there was no significant difference in HR magnitude between studies that controlled for any measure of health and the remaining studies ($p = 0.1236$). Model 3, however, shows that the mean HR was 24% lower for studies that controlled for one or more health behaviors, when compared to the remaining studies ($p = 0.0159$). These results suggest that health behaviors may confound the unemployment-mortality association to some degree. However, the results also indicate that pre-existing health behaviors and conditions do not account for 100% of the relationship between unemployment and mortality (see the discussion for more on this issue).

Previous studies suggested that gender is a key moderating variable for the unemployment-mortality association. Preliminary examinations of individual studies revealed qualitative differences between the magnitude of HRs for men and for women, suggesting that women and men be analyzed separately. Table 3 shows that unemployment was associated with an increased risk of death when HRs were adjusted for age and additional covariates. However, gender-specific analyses show that the magnitude of the association was greater for men (HR, 1.78; 95% CI, 1.56–2.02; $n = 54$ HRs) than for women (HR, 1.37; 95% CI, 1.17–1.60; $n = 36$). Model 3 of Table 5 confirms that the proportion of a sample that is male had a significant impact on the magnitude of the HR. The risk of death for men was 37% higher than that for women ($p < 0.001$).

Previous research has also suggested that age may moderate the association between unemployment and mortality. We therefore also conducted sub-group analyses based on average age at baseline. As shown in Table 3, unemployment was associated with a 73% increased risk of all-cause mortality for people under the age of 40 years who were in their early careers (HR, 1.73;95% CI, 1.41–2.11; $n = 29$) and a 77% increased risk for those between the ages of 40 and 50 years who were in mid-career (HR, 1.77; 95% CI, 1.59–1.98; $n = 70$). The association was substantially reduced for those between the ages of 50 and 65 years who were near the end of their working careers (HR, 1.25; 95% CI, 1.03–1.52; $n = 19$). The results of the meta-regression analysis (Model 3 of Table 5) show a significant effect for mean age (a 6% decrease for each additional 10 years; $p = 0.0165$) confirm this finding, with HR magnitude being approximately equal between the youngest and the middle age group ($p = 0.4394$) but 26% lower for the oldest age group ($p = 0.0016$).

While follow-up duration has not often been explored in the literature as a moderating factor, preliminary examinations of individual studies suggested that the association between unemployment and mortality may change as time passes. Sub-group analyses based on follow-up duration (Table 3) show that people who experienced unemployment had a 73% higher risk of death during the first 5 years of follow-up (HR, 1.73; 95% CI, 1.44–2.06; $n = 30$). The elevation of risk of death remained approximately the same when the follow-up duration averaged 5 to 10 years (HR, 1.76; 95% CI, 1.55–2.00; $p < 0.001$; $n = 47$) but then decreased to a 42% elevation of risk in studies with a follow-up of more than 10 years (HR, 1.42; 95% CI, 1.22–1.64; $n = 43$). However, the meta-regression results indicate that there was no significant trend associated with follow-up duration ($p = 0.3476$).

Furthermore, the type of comparison group used may also have an effect on the magnitude of the mean HR. Preliminary comparisons of individual studies confirmed this, leading us to also examine sub-groups results based on the type of comparison group used. The mean HR was much higher when the comparison group was employed persons only (HR, 1.75; 95% CI, 1.54–1.98; Table 3) than when the comparison group was the general population (HR, 1.24; 95% CI, 1.01–1.51). The results of meta-regression analysis (Table 5) confirm this, showing that HRs were 32% lower when the general population was used as the comparison group ($p < 0.001$). Table 3 also shows that the risk of death was marginally lower when studies excluded persons not in the labor force (HR, 1.60; 95% CI, 1.45–1.76) than when studies included a mixture of unemployed persons and those who were not in the labor force (HR, 1.73; 95% CI, 1.46–2.04). However, the meta-regression analyses (Table 5) show that when unemployed persons were combined with persons not in the labor force the HR increased by 46% ($p < 0.001$) once other study-level factors were controlled.

Table 3
Meta-analyses.[a]

Data	Unadjusted	Adjusted for age only	Adjusted for age and additional covariates[b]
All available data	2.08 (1.77, 2.43)	1.59 (1.42, 1.77)	1.63 (1.49, 1.79)
Non-estimated death rate only	2.04 (1.73, 2.40)	1.48 (1.30, 1.68)	1.66 (1.48, 1.86)
Non-estimated standard error only	2.08 (1.77, 2.43)	1.67 (1.48, 1.89)	1.69 (1.54, 1.85)
Sex			
Women only	1.62 (1.25, 2.09)	1.31* (1.10, 1.56)	1.37 (1.17, 1.60)
Men only	2.38 (1.85, 3.08)	1.79 (1.56, 2.05)	1.78 (1.56, 2.02)
Average age (y)			
<40	1.84 (1.37, 2.48)	1.66 (1.39, 1.97)	1.73 (1.41, 2.11)
40–49.9	2.25 (1.87, 2.71)	1.77 (1.51, 2.08)	1.77 (1.59, 1.98)
50–65	1.64*** (0.97, 2.76)	1.33** (1.02, 1.74)	1.25** (1.03, 1.52)
Mean follow-up duration (y)			
≤5	1.70* (1.15, 2.52)	1.50 (1.26, 1.80)	1.73 (1.44, 2.06)
5.1–10	2.65 (2.15, 3.25)	1.83 (1.55, 2.15)	1.76 (1.55, 2.00)
>10	1.58 (1.22, 2.04)	1.37* (1.12, 1.67)	1.42 (1.22, 1.64)
Comparison group			
Employed	2.09 (1.79, 2.45)	1.75 (1.54, 1.98)	1.63 (1.50, 1.78)
General population	–	1.24** (1.01, 1.51)	–
Unemployment measure			
Unemployed only	1.75 (1.48, 2.08)	1.58 (1.41, 1.77)	1.60 (1.45, 1.76)
Unemployed or not in labor force	3.76 (2.75, 5.14)	1.62 (1.25, 2.10)	1.73 (1.46, 2.04)

* $p \leq 0.01$.
** $p \leq 0.05$.
*** $p > 0.05$.
[a] All meta-analyses were calculated by maximum likelihood using a random effects model. See Table 4 for information on sample sizes for each analysis. Values are presented as mean hazard ratio (95% confidence interval). Unless indicated otherwise $p \leq 0.001$. Ellipses indicate situations where $n \leq 1$ and meaningful mean HR could not be calculated.
[b] The number and type of covariates varies between studies.

Sensitivity analysis

The between-groups Cochrane's Q for the meta-analysis of all 235 HRs was statistically significant ($p = 0.0149$) and the I^2 statistic was quite high (I^2, 76.2; 95% CI, 22.1–92.8), indicating that important moderating variables exist and supporting the decisions to use random effects models and conduct sub-group meta-analyses. As shown in Table 4, the *Q*-tests for these sub-group meta-analyses were statistically significant only for statistically-unadjusted HRs. In all of the remaining sub-group analyses however, *Q*-tests and I^2 tests were non-significant, indicating that heterogeneity was adequately accounted for by the use of a random effects model. Since the discussion of the meta-analysis focused on HRs adjusted for age and additional covariates, the results discussed above are not an artifact of heterogeneity in the data.

To be conservative however, meta-regressions were used to examine other possible sources of heterogeneity in the data. The model fit statistics for Model 3 of Table 5 (R^2, 0.3702; $p < 0.001$ for

Table 4
Tests of heterogeneity and sample size information for the meta-analyses reported in Table 3.

	Unadjusted		Adjusted for age only		Adjusted for age and additional covariates	
	n	*Q*-test *p*-value	*n*	*Q*-test *p*-value	*n*	*Q*-test *p*-value
All available data	40	0.001	75	0.892	120	0.999
Non-estimated death rate only	35	0.000	59	0.996	78	0.999
Non-estimated SE only	37	0.000	60	0.950	114	0.999
By sex						
Women	13	0.024	30	0.755	36	0.956
Men	13	0.015	44	0.896	54	0.939
By average age (y)						
≤40	12	0.466	33	0.993	29	0.958
40–49.9	23	0.000	28	0.254	70	0.999
50–65	5	0.957	10	0.877	19	0.817
By mean follow-up duration (y)						
≤5	7	0.750	27	0.475	30	0.917
5.1–10	18	0.000	27	0.395	47	0.993
>10	15	0.529	21	0.993	43	0.914
By comparison group						
Employed	39	0.000	55	0.770	120	0.999
General population	1	–	20	0.999	0	–
By unemployment measure						
Unemployed only	31	0.090	61	0.747	90	0.991
Unemployed or not in labor force	9	0.002	12	0.360	30	0.911

Table 5
Bivariate and multivariate meta-regression analyses predicting the magnitude of the effect of unemployment on mortality.[a]

Variable	Multivariate model 1	Multivariate model 2	Parsimonious model[b]
Death rate estimated? (1, Yes; 0, No)	1.00 (0.44, 2.80)	1.00 (0.86, 1.18)	–
Standard error estimated? (1, Yes; 0, No)	0.84 (0.64, 1.08)	0.83 (0.64, 1.08)	–
Proportion of sample that is male (0 to 1)	1.35* (1.18, 1.54)	1.35* (1.19, 1.54)	1.37* (1.21, 1.56)
Mean age of study sample at baseline (reference group, <40)	–	–	–
40–49.9	0.99 (0.83, 1.18)	0.99 (0.83, 1.18)	1.06 (0.92, 1.22)
50–65	0.70** (0.56, 0.87)	0.70* (0.56, 0.86)	0.74** (0.61, 0.89)
Study age (per 10 y)	1.02 (0.93, 1.13)	1.02 (0.92, 1.13)	–
Years between end of baseline and start of follow-up	1.06** (1.02, 1.10)	1.05** (1.01, 1.10)	1.06* (1.03, 1.10)
Years between end of baseline and end of follow-up	0.99 (0.97, 1.01)	0.99 (0.97, 1.01)	–
Comparison group (1, general population; 0, employed persons)	0.67** (0.50, 0.88)	0.66** (0.50, 0.87)	0.68* (0.55, 0.83)
Unemployment measure (1, any non-working; 0, unemployed only)	1.49* (1.23, 1.79)	1.51* (1.25, 1.82)	1.46* (1.27, 1.69)
Region (reference group, other developed nations)	–	–	–
United States	1.02 (0.82, 1.28)	1.03 (0.83, 1.29)	–
Scandinavia	1.00 (0.78, 1.27)	1.01 (0.79, 1.29)	–
Controlled for sex (1, Yes; 0, No)	0.89 (0.71, 1.11)	0.87 (0.70, 1.09)	–
Controlled for age (1, Yes; 0, No)	0.83*** (0.70, 0.97)	0.84*** (0.72, 0.99)	0.84*** (0.72, 0.97)
Controlled for socioeconomic status (reference group, no controls)	–	–	–
Controlled for only education or only income (1, Yes; 0, No)	1.48 (0.99, 2.23)	1.24 (0.87, 1.77)	1.17 (0.87, 1.58)
Controlled for two or more SES measures (1, Yes; 0, No)	0.87 (0.76, 1.00)	0.87*** (0.75, 1.00)	0.87*** (0.77, 0.98)
Controlled for health	–	–	–
Controlled for any health status variable (1, Yes; 0, No)	0.84 (0.67, 1.05)	–	–
Controlled for health behaviors specifically (1, Yes; 0, No)	–	0.75*** (0.58, 0.96)	0.76*** (0.60, 0.95)
Log of sample size	1.01 (0.97, 1.05)	1.00 (0.96, 1.04)	–
Newcastle-Ottawa quality rating	1.05 (0.96, 1.14)	1.05 (0.96, 1.14)	–
Constant	1.11	1.25	1.62*
R^2	0.3875	0.3974	0.3702
Unexplained heterogeneity variance component	0.0972*	0.0959*	0.1017*

* $p \le 0.001$.
** $p \le 0.01$.
*** $p \le 0.05$.
[a] All meta-regressions were calculated by maximum likelihood using a random effects model. N = 235 hazard ratios for all analyses. Numbers reported are the exponentiated regression coefficients (exponentiated 95% confidence intervals). Ellipses indicate situations when a variable was not entered into a model.
[b] Obtained using backwards elimination, variables removed if $p > 0.10$.

the Cochrane's Q of the model) indicate that this model captured a very substantial portion of the heterogeneity in the data. Nevertheless, the unexplained heterogeneity variance component for this and the other models shown in Table 5 was highly significant (each $p < 0.001$), confirming the need to use a random effects model for all analyses.

As reported earlier, health behaviors, sex, mean age, and the composition of the case and control groups moderate the mean HR. Model 3 of Table 5 shows that other significant moderators include the time elapsed between the end of baseline and the beginning of follow-up (a 6% increase in risk for each additional year; $p = 0.0006$), whether the risk estimate was adjusted for age (a 16% decrease when age was controlled; $p = 0.0159$), and whether the risk estimate was adjusted for socioeconomic status (a 13% decrease when SES was well-controlled; $p = 0.0265$). While HRs from the United States and the Scandinavian nations are over-represented in the data, the results do not seem to be biased by this factor as there was no significant difference in HR magnitude between either region and the remaining nations ($p = 0.7707$ and $p = 0.9216$, respectively).

Of the 235 HRs, 93 were statistically-adjusted for age or had an age range smaller or equal to 35 years, did not use the general population as the control group, did not include persons not in the labor force in the case group, were from studies with less than a one year gap between the end of baseline and the beginning of follow-up, and were from studies in which men and women were analyzed separately. These 93 HRs were then grouped according to sex and age group, the resulting six sub-groups subjected separately to meta-analysis (see Table 6). The mean HR among women under the age of 40 was 1.73 (95% CI, 1.41–2.11; *n*, 19), was 1.34 (95% CI, 1.15–1.56; *n*, 14) when the mean age was 40 to 49.9 years, and was 0.94 (95% CI, 0.80–1.11; *n*, 9) when the mean age was 50 years or above. The mean HR among men under the age of 40 was 1.95 (95% CI, 1.69–2.26; *n*, 26), was 1.86 (95% CI, *n*, 14) when mean age was 40 to 49.9 years, and was 1.17 (95% CI, 1.00–1.36; *n*, 11) when the mean age was greater than or equal to 50 years. In all six meta-analyses, the *Q*-test was not significant and the I^2 statistic was not significantly different from zero, indicating homogeneity in the data. The high correspondence between these six more conservative meta-analyses and the full sample meta-analyses reported in Table 3 further confirm that heterogeneity in the sub-group data was not a major problem.

Discussion

Our findings show that unemployment was associated with an increased relative risk of all-cause mortality. We show that the risk of death was 63% higher among those who experienced

Table 6
Meta-analyses stratified by gender and age.[a]

Gender	Mean age	HR (95% CI)	*n*	*Q*-test *p*-value
Women	Less than 40	1.73* (1.41, 2.11)	19	0.937
	40–49.9	1.34* (1.15, 1.56)	14	0.233
	50–65	0.94 (0.80, 1.11)	9	0.999
Men	Less than 40	1.95* (1.69, 2.26)	26	0.398
	40–49.9	1.86* (1.63, 2.12)	14	0.842
	50–65	1.17** (1.00, 1.36)	11	0.365

* $p \le 0.001$.
** $p \le 0.05$.
[a] Analyses based on 93 hazard ratios that were statistically-adjusted for age or had an age range smaller or equal to 35 years, did not use the general population as the control group, did not include persons not in the labor force in the case group, and were from studies with less than a one year gap between the end of baseline and the beginning of follow-up.

unemployment than among those who did not, after adjustment for age and other covariates. Before proceeding to a more detailed discussion of the specific findings, however, some important limitations must be considered.

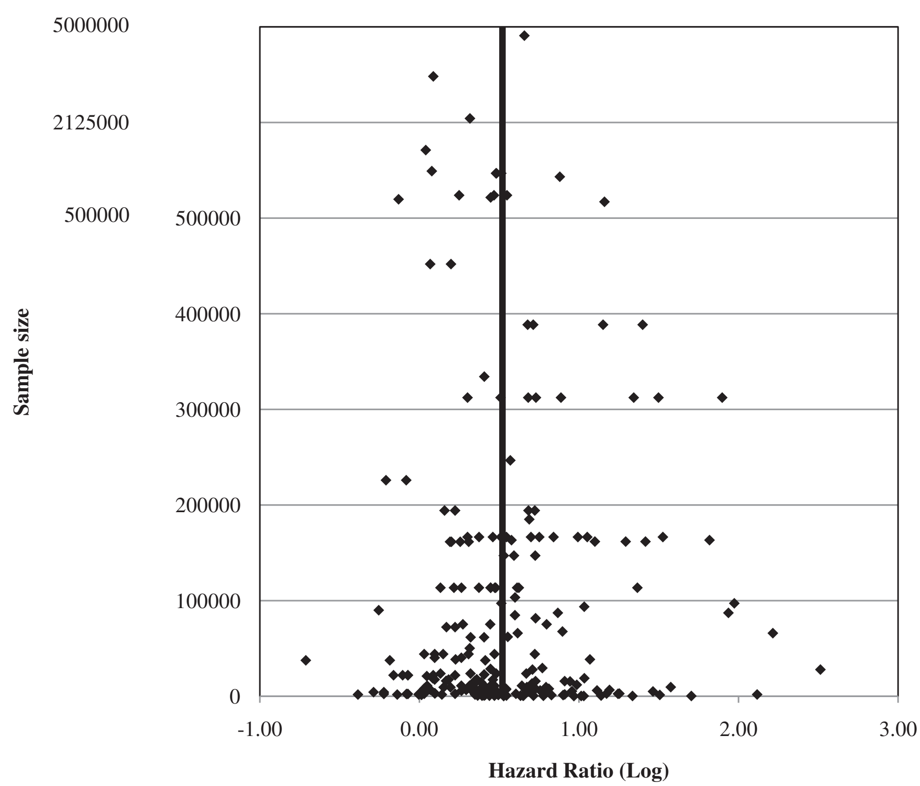
Limitations

There is also an unknown degree of nonreporting of non-significant findings (also known as the file-drawer effect) and selection bias that may affect the results (Berman & Parker, 2002; Egger & Davey-Smith, 1998). For example, some may suggest that the inclusion of studies based on census data is problematic because their analyses often rely on comparisons with the general population, as opposed to the employed population. While this is a valid point, we have tried to control for this by including the appropriate indicator variables in the analysis. To guard against other aspects of selection bias, we excluded no publications containing data on the association between unemployment and mortality. As with all meta-analyses however, some studies of the association between unemployment and mortality will have been missed. The funnel plot of the log HRs against sample size appears asymmetric around the mean HR, suggesting significant selection bias (Fig. 2). The results of Egger's test indicated significant funnel plot asymmetry ($p < 0.001$). However, recent simulation studies indicate that heterogeneity in the data (such as is the case here) produces misleading Egger's test results (Moreno et al., 2009; Peters et al., 2006; Terrin, Schmid, Lau, & Olkin, 2003). Using Peters' test (Moreno et al., 2009; Peters et al., 2006), we regressed the log HRs on the inverse of the sample size. The results of this second test indicated non-significant levels of funnel plot asymmetry after data heterogeneity had been taken into account ($p = 0.993$). Given the discrepancy in the results of the two tests, however, caution is warranted in the interpretation of the results.

Another limitation stems from the reliance on studies with observational designs, which limit the ways in which one can account for potential confounders. None of the studies of unemployment were randomized clinical trials, as unemployment is not a "treatment" one induces. In the worst case scenario, the use of an observational design creates the risk that one or more highly important confounding factors are not accounted for and the results of the study are biased (Egger, Schneider, & Davey-Smith, 1998). Even when important factors are controlled, differences in the method of control between studies have the potential to affect the results of a meta-analysis. For example, Model 3 in Table 5 shows that the method for controlling for socioeconomic status affects the magnitude of the HR. While the HR associated with unemployment is elevated across all levels of control for SES, the mean HR was 13% lower among the subset which measured SES using two or more factors. There is a danger of systematic bias in our results due to our reliance on studies with observational designs and due to the different methods used to control for confounders in the studies we examined. However, this danger is reduced by our efforts to account for the mediating, moderating, and confounding factors that have thus far been investigated in the literature.

Discussion

Three findings from our study support the idea that the pathway between unemployment and mortality is not completely spurious, and could be consistent with a causal association. First,



[a]Vertical line denotes the mean log hazard ratio of 0.52. To better show the dispersion of points, the y-axis scale is less condensed from 0 to 500 000 and more condensed from 500 000 to 5 000 000.

Fig. 2. Funnel plot of logarithmic hazard ratios vs. sample size[a].

unemployment remains associated with an increased risk of death even after the exclusion of individuals who were not in the labor force. This supports Moser et al.'s (1987) finding that elevated risk levels among the unemployed were not simply an artifact of misclassification. Second, the lack of significant difference between the subset of our data where health was directly controlled ($n = 45$ HRs) and the remaining data ($p = 0.1236$) suggests that pre-existing health problems were not, in a broad sense, the common cause of both unemployment and mortality. These findings are consistent with those of Lundin et al. (2010), who reported that a substantial portion of the association between unemployment and mortality remained even after accounting for possible confounding factors. However, our regressions indicated that the 27 HRs that controlled for health behaviors were 24% lower than the remaining HRs ($p = 0.0159$). This latter result provides limited support for the latent sickness hypothesis. Health-related behaviors existing at baseline account for a portion of the unemployment-mortality association and are clearly important to include in future studies. However, the coping hypothesis provides a better overall explanation as the lack of large differences in HR magnitude suggests that the post-unemployment pathway exerts a stronger effect on mortality outcomes. The method available to us for the testing of these competing hypotheses, while suggestive of the overarching patterns, cannot provide definitive evaluations of these hypotheses.

The results of this systematic review confirm our early expectations that the estimated adverse association between unemployment and mortality would not be uniform across all sub-groups and studies. Meaningful differences were observed by age group, gender, follow-up duration, time period, geographic region, and case and control group composition.

First, mean HRs were higher for those in their early and middle careers (an increased risk of 73% and 77%, respectively) but lower for persons in their late careers (only a 25% increase in risk), a finding consistent with those of earlier reports (Iversen, Andersen, Andersen, Christoffersen, & Keiding, 1987; Moser, Fox, & Jones, 1984; Sorlie & Rogot, 1990). This pattern may be the result of a smaller net increase in stress among older workers, who often hold jobs with above average stress levels and who may have already been contemplating retirement (Brenner & Levi, 1987). The pattern may also result from health selection into retirement among older workers (Disney, Emmerson, & Wakefield, 2006), a process that leads to the overrepresentation of healthier older persons in the workforce. Some caution must be exercised when interpreting this finding. When the underlying death rates are very high in both the case and control groups (as is the case at older ages), ratio statistics such as the HR lack statistical power to detect group differences. However, this is not likely a problem in the present study because we focus on the working-age population. The death rates remain low enough to enable ratio-type measures such as HRs to detect differences in death rates between the employed and unemployed.

Second, this study confirms that the magnitude of the association between unemployment and mortality is higher for men than for women (an increased risk of 78% vs. 37%). There are two possible explanations for this finding. First, the labor force participation rate for women is considerably lower than for men in most nations. Being engaged in unpaid labor at home or employed as part-time or on a temporary basis may provide less health protection than full-time work. The data can be used to partially evaluate this first explanation. The difference between men's and women's labor force participation rates is particularly low in the Scandinavian nations, and if this first explanation is valid one would expect to see a correspondingly smaller difference between men's and women's relative mortality risk. To test this we included an interaction term between gender and Scandinavian region in a separate meta-regression (not shown in tables, but using the same covariates as Model 2 in Table 5). The lack of significance for the interaction term ($p = 0.8156$) suggests that absolute differences in the labor force participation rate between men and women do not account for differences in the relative mortality risk. A second explanation for the gender gap in relative mortality risks may be that employment status remains more central to men's identities than to women's *despite* the continuing upward trend in women's participation in the formal labor market. This explanation cannot be evaluated with our data.

Third, the association between unemployment and mortality is significant in both the short and long term. While the meta-analysis results showed a decrease in the mean risk of mortality in those studies where the follow-up period exceeded 10 years (the risk dropped from 76% to 42%), this trend was not significant in the final meta-regression model ($p = 0.3476$). This finding must be approached conservatively as it may result from the fact that many of the studies included in the meta-analysis were cross-sectional. In cross-sectional studies the employment status reported at baseline tends to become less and less accurate as time passes. In other words, group differences may become obscured over time because some of those who initially reported being unemployed later found work and some who were employed at baseline (and served as the comparison group) later lost their jobs. The constancy of the mean relative risk over time, however, does lend some support to the hypothesis and previous findings that both the stress and the negative lifestyle effects associated with the onset of unemployment tend to persist even after a person has regained a job (Bolton & Rodriguez, 2009; Cohen et al., 2007; Janicki-Deverts, Cohen, Matthews, & Cullen, 2008; Khan, Murray, & Barnes, 2002; Montgomery et al., 1998; Wadsworth, Montgomery, & Bartley, 1999).

Fourth, the results of the meta-regression analyses show no significant changes in the magnitude of the unemployment-mortality association over the last four decades, as shown by the lack of a significant association between the age of a study and the magnitude of the HR (Model 2 of Table 5; $p = 0.6972$). Despite dramatic changes in the composition of the workforce and in work environments over this period (such as women's increased labor market participation, changing government unemployment policies, and the general trend towards more part-time and temporary jobs), the association between unemployment and mortality remained unchanged.

Fifth, the results of the meta-regressions suggest that differences between national welfare and health care systems may not translate into differences in the magnitude of the unemployment-mortality association. Ideally, this question would be tested using a direct measure of national health system scope. While this data was not available for our analyses, the geographic region variables can be used to partially assess the hypothesis. Among the nations represented in this study (see Table 2 for a complete list), only the United States lacks some form of universal health coverage. Furthermore, unemployment benefits in the United States tend to be less generous than in most of the other nations examined. In contrast, public health care coverage is most comprehensive in the Scandinavian nations. If the degree of coverage provided by national welfare and health care systems was related to the unemployment-mortality association, one would expect to see significant differences in HR magnitude between the U.S. and the Scandinavian nations. The lack of a significant difference between the mean HR for the U.S. ($p = 0.7707$), Scandinavia ($p = 0.9216$), and the remaining nations suggests that these national-level policy differences may not have much of an effect on the rate of mortality following unemployment. This result should be treated conservatively and should not be extrapolated to populations in developing countries, as almost all the data came from studies of the developed world.

Finally, the composition of both the cases and controls was important. When comparing unemployed persons with the general population, the effect is much smaller than when comparing unemployed persons with employed persons (the risk decreases from 75% to 24%). This is to be expected because the general population, while primarily consisting of employed persons, also includes some unemployed persons and individuals who are not in the labor force (e.g. early retirees, the disabled, homemakers, and students). Furthermore, the mean risk of death increases (from 60% to 73%) when those who are not in the labor force are mixed with the unemployed. This confounds the stress of unemployment with health status and other factors that may influence the magnitude of the association. These findings suggest that future studies of the unemployment-mortality association must strive to include only unemployed persons as cases and only employed persons as controls. The quality of study design is critical for assessing the risk of death among unemployed persons because this risk tends to be understated if cases or controls are not both precisely specified.

Conclusion

This study shows that unemployment was associated with a substantially increased risk of death among broad segments of the population. Future research should continue to focus on possible mediating, moderating, and confounding factors and on whether this risk is modifiable, either at the health system level or the individual level. Until more is known about the mechanisms by which this association occurs, more proactive primary prevention screening and interventions among the unemployed are needed. Due caution is warranted, however, as Dorling (2009) suggests that some interventions, such as low-wage work programs, appear to exacerbate the hazard of dying due to unemployment. However, studies suggest that cardiovascular screening programs among the unemployed, interventions aimed at increasing unemployed persons' awareness of behavioral risk factors (Hanewinkel, Wewel, Stephan, Isensee, & Wiborg, 2006), and stress-management programs (aimed at preventing risk-taking behavior that leads to the observed increase in injury rates among the unemployed) may be particularly beneficial. Studies such as the current one are particularly important in the current economic climate, with many national unemployment rates exceeding 10% and expected to remain elevated for some time. Much work remains to be done using more detailed specifications of unemployment for which systematic data could not be found. Studies should be conducted in developing nations, where welfare and health care systems are much less developed and unemployment may result in more direct threats to a person's health. Future studies should also collect data on unemployment duration, informal labor market participation, sources of support, and other possible mediators beyond those discussed in this paper.

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Appendix

Section 1: Full search algorithms for Medline.

1. exp stress, psychological/mo
2. exp Stress, Psychological/
3. exp mortality/
4. mo.fs.
5. (death$ or mortalit$ or fatal$).tw.
6. or/3–5
7. 2 and 6
8. 1 or 7
9. stress$.tw.
10. exp caregivers/
11. caregiv$.tw.
12. (care giver$ or care giving).tw.
13. exp family/
14. exp siblings/
15. exp divorce/
16. exp marriage/
17. (marital adj (strife or discord)).tw.
18. widow$.tw.
19. (marriage or married).tw.
20. divorce$.tw.
21. famil$.tw.
22. (son or sons).tw.
23. daughter$.tw.
24. (spous$ or partner$ or husband$ or wife or wives).tw.
25. (mother$ or father$ or sibling$ or sister$ or brother$).tw.
26. exp dissent/and disputes.mp. [mp = title, original title, abstract, name of substance word, subject heading word]
27. exp domestic violence/
28. domestic violence.tw.
29. ((child$ or partner$ or spous$ or elder$ or wife or wives) adj5 (violen$ or abuse$ or beat$ or cruelty or assault$ or batter$)).tw.
30. ((mental$ or physical$ or verbal or sexual$) adj2 (violen$ or abuse$ or cruelty)).tw.
31. exp PEDOPHILIA/
32. (pedophil$ or paedophil$).tw.
33. exp social class/
34. exp socioeconomic factors/
35. (socioeconomic$ or socio economic$).tw.
36. ((financ$ or money or economic) adj (stress$ or problem$ or hardship$ or burden$)).tw.
37. exp poverty/
38. (poverty or poor or depriv$).tw.
39. exp residence characteristics/
40. ((neighbo?rhood or resident$) adj (characteristic$ or factor$)).tw.
41. (crowd$ or overcrowd$).tw.
42. exp prejudice/
43. (prejudic$ or racis$ or discriminat$).tw.
44. exp social isolation/
45. exp social support/
46. (social adj (isolat$ or support$ or connect$ or depriv$ or function$ or influen$ or interact$ or relationship$ or separat$ or ties)).tw.
47. exp friends/
48. (acquaintance$ or companion$ or friend$).tw.
49. neighbo?r$.tw.
50. exp interpersonal relations/
51. (social adj network$).tw.
52. exp social behavior/
53. (social$ adj activ$).tw.
54. exp work/
55. exp employment/
56. exp job satisfaction/
57. exp work schedule/
58. exp occupational disease/
59. exp occupational health/

60. exp workplace/
61. (job or jobs).ti,ab.
62. employ$.ti,ab.
63. unemploy$.ti,ab.
64. (shiftwork$ or (work adj2 shift$)).ti,ab.
65. karasek$.ti,ab.
66. overwork$.ti,ab.
67. ((job or work or employ$ or occupation$) adj (satisf$ or condition$ or discontent or stress$)).ti,ab.
68. exp ACCULTURATION/
69. acculturat$.ti,ab.
70. (migrant$ or immigrant$ or guest work$).ti,ab.
71. exp Life Change Events/
72. ((trauma$ or life) adj (change or event$ or stress$)).ti,ab.
73. exp natural disasters/
74. (natural disaster$ or earthquake$ or hurricane$ or volcan$ or typhoon$ or tsunami$ or avalanche$ or fire$ or flood$).ti,ab.
75. exp FIRES/
76. exp STRESS DISORDERS, POST-TRAUMATIC/or exp OXIDATIVE STRESS/or exp ECHOCARDIOGRAPHY, STRESS/or exp HEAT STRESS DISORDERS/or exp DENTAL STRESS ANALYSIS/or exp STRESS, MECHANICAL/or exp STRESS FIBERS/or exp URINARY INCONTINENCE, STRESS/or exp FRACTURES, STRESS/or stress disorders, traumatic, acute/or exp exercise test/
77. ((stress or exercise) adj test$).sh,tw.
78. exp Accidents, Occupational/
79. (occupation$ adj (hazard$ or accident$)).tw.
80. or/76–79
81. 2 or 9
82. or/10–75
83. or/76–79
84. 82 not 83
85. and/6,81,84
86. 8 or 85
87. exp Cohort Studies/
88. Controlled Clinical Trials/
89. controlled clinical trial.pt.
90. ((incidence or concurrent) adj (study or studies)).tw.
91. comparative study.sh.
92. evaluation studies.sh.
93. follow-up studies.sh.
94. prospective studies.sh.
95. control$.tw.
96. prospectiv$.tw.
97. volunteer$.tw.
98. or/87–97
99. 86 and 98
100. limit 99 to humans

Section 2: Coding procedures and variables for which data were sought.

As already mentioned in the main text, two authors (DR and ES) trained in systematic review coding procedures determined publication eligibility and extracted the data from the articles. Prior to coding, both authors jointly reviewed the titles and abstracts of potential publications to determine whether a given work warranted a full examination for coding purposes. Each of these publications was read independently, with each author forming an opinion on final publication eligibility, assigning a tentative subjective quality rating, and highlighting the data to be coded (see below). The two authors then met in conference to discuss each publication. Data was entered into a spreadsheet only after agreement had been reached on final publication eligibility, the number of relative risk estimates available for extraction, the values to be assigned for the study design variables (e.g. age range, baseline date) corresponding to each relative risk, and consensus had been established with respect to the final subjective quality rating. In some cases, the data entry involved calculating relative risk estimates from raw death rates or from raw count data. For publications reporting multiple analyses of a single sample, data was sought from a statistically-unadjusted model, a model adjusted for age alone, and from the most statistically-adjusted multivariate model. Data was entered basic spreadsheets (the data spreadsheet being later imported into SPSS for analysis). The variables we sought to obtain from publications were:

1) Author names; 2) author genders; 3) publication date; 4) publication title; 5) place of publication; 6) characteristics of high stress group (e.g. unemployed); 7) characteristics of low stress group (e.g. employed); 8) characteristics shared by both high and low stress groups; 9) percent of the sample that was male; 10) minimum age; 11) maximum age; 12) mean age; 13) ethnicity; name of data source used; 14) geographic location of study sample; 15) baseline start date (day, month, year); 16) baseline end date (day, month, year); 17) follow-up end date (day month, year); 18) maximum follow-up duration; 19) average follow-up duration; 20) information on timing of stress relative to baseline start date; 21) information on the structure of the follow-up period (e.g. were there any gaps between the end of baseline and the beginning of follow-up?); 22) statistical technique used; 23) total number of persons analyzed in the publication; 24) total number of persons analyzed for the specific effect size; 25) number of persons in the high stress group; 26) number of deaths in the high stress group; 27) number of persons in the low stress group; 28) number of deaths in the low stress group; 29) death rate in the high stress group; 30) death rate in the low stress group; 31) effect size; 32) confidence interval; 33) standard error; 34) *t* statistic; 35) Chi-square statistic; 36) minimum value for *p*-value; 37) maximum value for *p*-value; 38) full list of control variables used; 39) date of data extraction; 40) subjective quality rating; 41) number of citations received by publication according to Web of Science; 42) number of citations received according to Google Scholar; 43) 5-year impact factor for place of publication.

Section 3: Additional information on the conversion of odds ratios and relative risks to hazard ratios.

All non-hazard ratio point estimates were converted to hazard ratios (the most frequently reported type) using one or both of the following equations (Zhang & Yu, 1998): $\mathrm{RR} = \mathrm{OR}/((1-r)+(r \times \mathrm{OR}))$ and $\mathrm{HR} = \ln(1-\mathrm{RR} \times r)/\ln(1-r)$, where RR is the relative risk, OR is the odds ratio, HR is the hazard ratio, and *r* is the death rate for the reference (i.e. employed) group.

Section 4: Additional information on the estimation of death rates and standard errors.

Significant predictors of the death rate were follow-up duration, mean age at baseline, sample size (log transformed), an indicator for whether the study statistically controlled for gender, the subjective quality assessment score assigned by the coders, the proportion of the sample that was male, and an indicator for whether the study statistically controlled for age.

Multiple $R = 0.797$. As mortality is the outcome variable in the included studies, it needs to be made explicit that it was the death rate (used to convert different measures of relative risk to a common metric) that was estimated, not the mortality risk estimate itself.

Significant predictors of the standard error were sample size (log transformed), mean age at baseline, follow-up duration, the magnitude of the hazard ratio, and publication date.

Multiple $R = 0.721$.

Section 5: Additional information on method for adjusting inverse variance weights.

Many meta-analysts prefer to use only the most general point estimates reported in a given publication. While this strategy makes it easier to maintain independence between point estimates and makes the calculations of the inverse variance weights straight-forward, it also results in a substantial loss of information. We sought instead to maximize the number of point estimates analyzed, capturing variability both between and within each publication rather than just the former. For example, when a publication (see hypothetical Study X in Table A1) reported mortality risks by gender sub-groups alone the data requires no adjustment. Likewise, when a study reported mortality risks by age group alone (see hypothetical Study Y) the data also requires no adjustment. However, when a publication first reports mortality risks by gender and then again by age (see hypothetical Study Z) this creates a violation of independence because each person is represented twice. To correct for this double-counting, each of the variance weights was adjusted to half of its original value, thus preserving information on the gender and age variables while effectively counting each subject only once.

Table A1
Illustration of adjustments made to the inverse variance weights to correct for double reporting.

Author, publication year	Gender	Age	Original inverse variance weight	Corrected inverse variance weight
Study X	Men only	All ages	4	4
Study X	Women only	All ages	2	2
Study Y	Men only	20-44	5	5
Study Y	Men only	45-65	7	7
Study Y	Men only	65+	3	3
Study Z	Men only	All ages	12	6
Study Z	Women only	All ages	20	10
Study Z	Both men & women	20–44	16	8
Study Z	Both men & women	45–65	24	12
Study Z	Both men & women	65+	16	8

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Attachments from Comment Letter R92

ATTACHMENT A

Traffic Technical Report
for the
Gardner Intermodal Facility
Johnson County, Kansas

May 2009

TRAFFIC
TECHNICAL REPORT

PROPOSED GARDNER INTERMODAL FACILITY
Johnson County, Kansas

May 2009

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List of Acronyms and Abbreviations Used	
Acronym or Abbreviation	**Definition**
AASHTO	American Association of State Highway and Transportation Officials
ADT	average daily traffic
AWSC	all-way stop-controlled intersection
BIA	Break-in-Access
BNSF	BNSF Railway Company
DOT	Department of Transportation
EB	eastbound
FD	Fire District
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
Gardner IMF	Gardner Intermodal Facility
HCM	Highway Capacity Manual
I-35	Interstate 35
IMF	Intermodal Facility
ITE	Institute of Transportation Engineers
K-33	Kansas Highway 33
KDOT	Kansas Department of Transportation
KHP	Kansas Highway Patrol
LOS	level of service
LRTP	Long-Range Transportation Plan
MARC	Mid-America Regional Council
MP	milepost
mph	miles per hour
MVMT	million vehicle miles traveled
N/A	not applicable
NB	northbound
NW	northwest bound
pc/mi/ln	passenger cars per mile per lane
OWSC	one-way stop-controlled intersection
PDO	property damage only
sec/veh	seconds per vehicle
SB	southbound
TAG-KC	The Allen Group – Kansas City
TWSC	two-way stop-controlled intersection
USACE	U.S. Army Corps of Engineers
US 56	U.S. Highway 56
vpd	vehicles per day
VS	Verified Statement
WB	westbound

1.0 INTRODUCTION

The purpose of this technical report is to characterize the affected environment for transportation and traffic and anticipated environmental consequences to this resource (transportation and traffic) as a result of the Proposed Action, the Wellsville North Alternative, and the No Action Alternative. Detailed discussions of the description of the Proposed Action, the purpose and need of the Proposed Action, and alternatives to the Proposed Action are provided in the *Purpose and Need and Alternatives Analysis Technical Report* (HDR, 2008a). BNSF Railway Company's (BNSF) preferred site for the proposed intermodal facility is west of Gardner, Kansas. At the request of the U.S. Army Corps of Engineers (USACE), the Wellsville North Alternative has also been brought forward for analysis and comparison. This technical report incorporates comments provided by the Federal Highway Administration (FHWA) and the Kansas Department of Transportation (KDOT) during early coordination with these agencies.

2.0 AFFECTED ENVIRONMENT

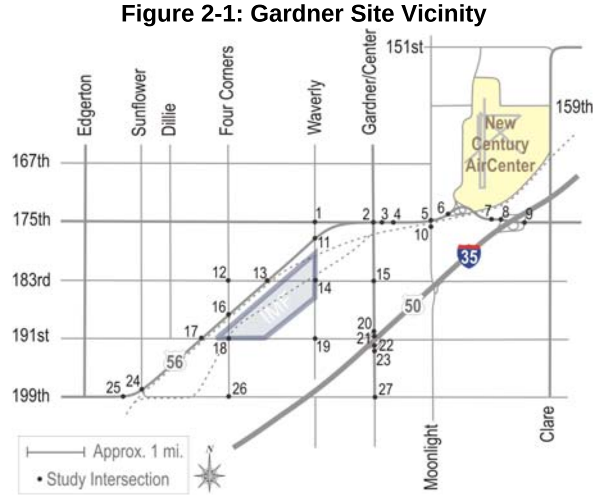
The affected environment section documents the existing transportation system in the vicinity of the Proposed Action and the Wellsville North Alternative. The project area for each site includes the intermodal facility (IMF) footprint (project site) plus off-site rail and roadway improvements. The traffic study areas for the Proposed Action and the Wellsville North Alternative are based on the existing transportation networks in the vicinity of each project site as defined in Sections 2.1.2 and 2.2.2, respectively. This section includes a description of the current roadways, intersections, and rail facilities as well as an assessment of current conditions with respect to traffic volumes, and operations. The affected environments for the Proposed Action and the Wellsville North Alternative are addressed sequentially in the following sections. The methodology used to characterize the affected environment is included in Appendix A.

2.1 Gardner

2.1.1 Gardner Traffic Study Area

The project site is located south of U.S. Highway 56 (US 56) and between 191st Street and Waverly Road, as shown in Figure 2-1. The site is situated southwest of the City of Gardner in unincorporated Johnson County. The traffic study area was the geographic focus for data collection, travel demand forecasting, and traffic operations analysis and is described in Section 2.1.2. This analysis focuses on major roadways and minor roadways expected to carry project-related traffic. A larger area was considered in developing regional assumptions regarding truck distribution patterns. This larger area considered the freeway and interstate system of the entire Kansas City metropolitan area to the extent practical.

Figure 2-1: Gardner Site Vicinity



More important than the development of a geographical study area is the identification of specific facilities (intersections and highway segments) to be analyzed from a traffic operations standpoint. The methodology used in identifying these is described in Appendix A.

2.1.2 Existing Transportation Network in the Vicinity of the Proposed Action

This section describes existing transportation facilities within and near the Gardner traffic study area in 2008. It does not include the 159th Street and Lone Elm Road I-35 interchange that is currently under construction.

Existing Roadway Network

The Gardner traffic study area includes the following roadway and highway facilities, listed in decreasing order of functional classification. Figure 2-2 illustrates the existing roadway network and 2008 average daily traffic (ADT) volumes within the study area.

- *Interstate 35 (I-35)* is a 4-lane interstate highway running northeast-southwest through the study area. It has a posted speed limit of 70 miles per hour (mph). It provides access from Gardner to the rest of the Kansas City metro area. In the vicinity of 151st Street, I-35 widens to six lanes. I-35 currently carries approximately 21,000 to 45,500 vehicles per day (vpd) in the study area.
- *US 56 (Main Street in downtown Gardner)* is a rural 2-lane highway southwest of Gardner, with a posted speed of 55 mph and 2008 volumes of 4,800 vpd or lower. From east of Waverly Road to the US 56/I-35 interchange, it is a 4-lane undivided arterial with posted speeds of 30 to 45 mph. It crosses the BNSF mainline on a grade-separated overpass west of the I-35 interchange. Traffic volumes along this more urban portion of US 56 range from 5,000 to 26,000 vpd.
- *Gardner Road (Center Street in downtown Gardner)* is a 2- to 4-lane collector that provides the main north-south connection between downtown Gardner and I-35. It provides one of two grade-separated crossings of the BNSF tracks in the traffic study area. The grade-separated structure carries one lane in each direction. Traffic volumes on Gardner Road range from 5,000 to 7,000 vpd depending on location.
- *Moonlight Road* is a 2-lane north-south minor collector that carries 8,000 to 11,000 vpd in the vicinity of US 56. Further south, closer to I-35, traffic volumes are considerably lower (2,500 vpd and below). Moonlight Road provides access to the southeastern portions of Gardner and crosses the BNSF mainline tracks at grade less than 150 feet south of US 56.
- *175th Street* (Santa Fe Street, Main Street) coincides with US 56 from 0.5 mile west of Center Street to the I-35 interchange. West of US 56, it is a 2-lane (35 mph) east-west collector providing access to residential developments, Gardner Municipal Airport, and agricultural parcels. East of I-35, 175th Street is also a 2-lane collector. Traffic volumes are shown in Figure 2-2.
- *Waverly Road* is a north-south 2-lane roadway (35 mph). South of US 56, Waverly Road is a gravel road carrying fewer than 150 vpd and providing access to largely undeveloped/agricultural parcels. North of US 56, it is paved, carries volumes of 600 to 1,800 vpd, and provides access to residential areas as well as two schools. Between US 56 and 183rd Street, Waverly Road crosses both BNSF railroad tracks at grade.
- *Four Corners Road* is a paved 2-lane collector (45 mph) extending north from 199th Street through the study area. It crosses the BNSF railroad tracks at grade south of US 56. Within the study area, Four Corners Road carries fewer than 250 vpd.
- *183rd Street* is an east-west 2-lane roadway. From 0.5 mile east of Waverly Road to the west, it is a gravel or chip-sealed road (35 mph) serving undeveloped/agricultural parcels, and crossing both BNSF tracks at grade. To the east, 183rd Street is paved

and provides access to several residential developments. Volumes are shown in Figure 2-2.

- *191st Street* is a low-volume 2-lane 35-mph east-west gravel roadway (with the exception of a short paved section near Gardner Road). It crosses the BNSF tracks at grade east of US 56. At Four Corners Road, 191st Street is offset to avoid crossing the BNSF tracks again. It is also discontinuous on either side of the I-35/Gardner Road interchange.

- *199th Street* is a 2-lane paved collector in the study area. Between US 56/Sunflower Road and Gardner Road, it has a posted speed of 45 mph and crosses the BNSF tracks twice (at-grade) and I-35 once (with a 2-lane overpass). Near US 56, it curves north to meet Sunflower Road. West of this intersection, 199th Street coincides with US 56 as a 2-lane east-west paved roadway. Traffic volumes are shown in Figure 2-2.

- *Sunflower Road* is a paved 2-lane north-south collector located near the west edge of the study area. It connects I-35 with the City of Edgerton; however, it is discontinuous in the vicinity of US 56 and the BNSF tracks. After it turns west to become Nelson Street near Edgerton, the road crosses the BNSF mainline at grade.

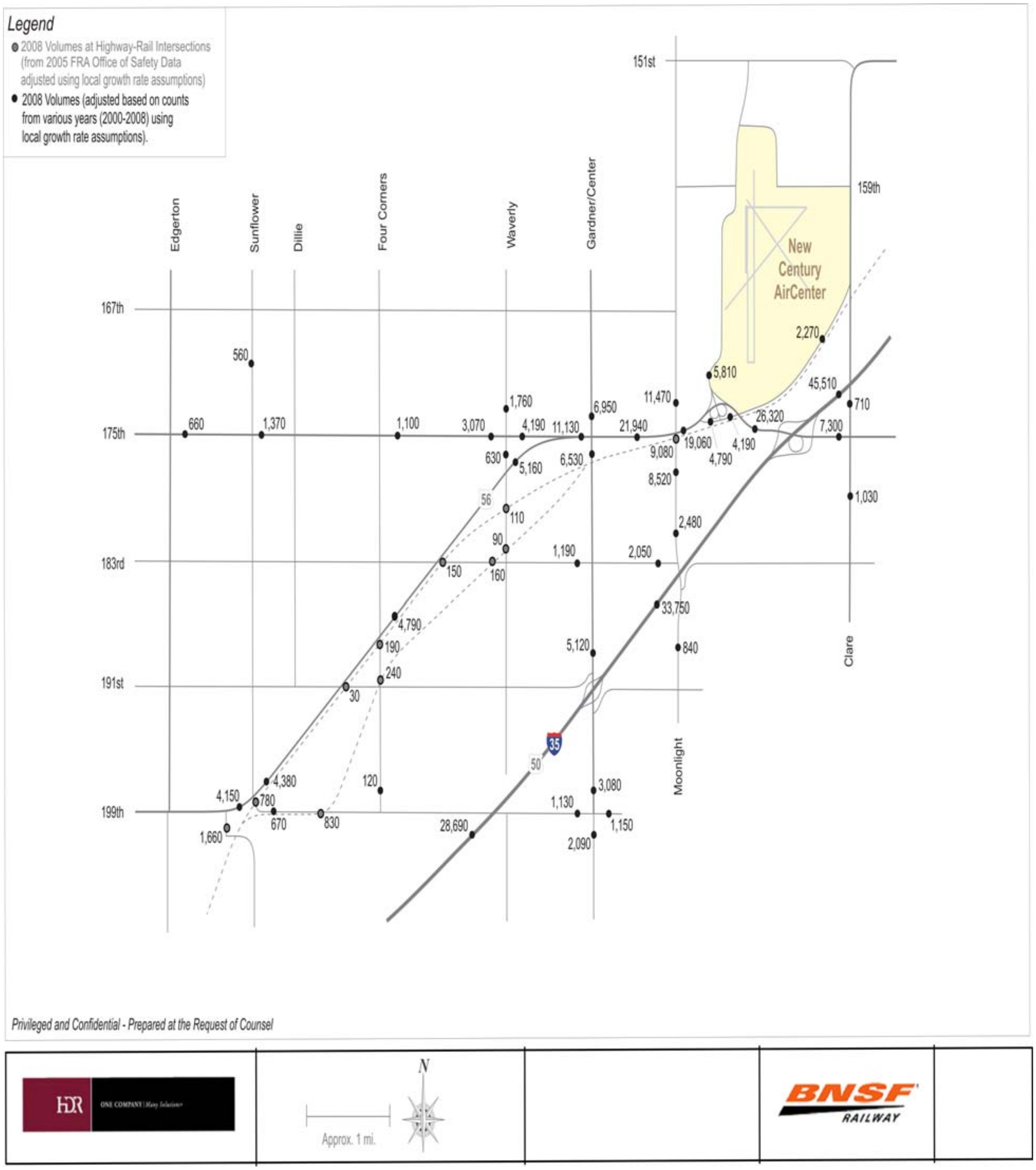
- *Edgerton Road* is a paved north-south collector at the western study area boundary. It provides access to the growing western portion of the City of Edgerton.

The functional classifications and access types for the aforementioned roadways are listed in Table 2-1.

Table 2-1: Gardner Study Area Roadways

Roadway	Functional Classification	Access Control
I-35	Interstate	Full Access Control
US 56	State Arterial Route	Varies (None to Partial)
Gardner Road	Major Collector	None
Moonlight Road	Minor Collector	None
175th Street	Major Collector	None
Waverly Road	Rural Local	None
Four Corners Road	Major Collector	None
183rd Street	Rural Local	None
191st Street	Rural Local	None
199th Street	Major Collector	None
Sunflower Road	Major Collector	None
Edgerton Road	Major Collector	None

Figure 2-2: Existing (2008) ADTs



Existing Interchanges

Three I-35 interchanges are located in the study area and are listed from north to south as follows:

- The I-35/US 56 interchange is approximately 5 miles southwest of the I-35/151st Street interchange. It provides access to and from the City of Gardner and the New Century AirCenter. The interchange is a partial ("one-fourth") cloverleaf configuration with diamond-type ramps for all movements except eastbound to northbound, which has a loop ramp. The diamond ramp intersections are unsignalized.

- The I-35/Gardner Road interchange is approximately 3 miles southwest of the I-35/US 56 interchange. It provides access to the City of Gardner to the north and Miami County to the south. The interchange is a diamond configuration, with Gardner Road as a 2-lane overpass. Both ramp intersections currently operate under stop control.

- The I-35/Sunflower Road interchange is approximately 5 miles southwest of the I-35/Gardner Road interchange. It is a diamond interchange, with Sunflower Road as a 2-lane overpass. The ramp intersections operate under stop control. The interchange provides access to the City of Edgerton to the north and Miami County to the south.

The intersection of US 56 and New Century Parkway is a grade-separated interchange with loop ramps for the eastbound-to-northbound and southbound-to-eastbound movements, and "diamond" ramps for the southbound-to-westbound and westbound-to-northbound movements. All of the ramps are free flow. This interchange primarily serves the New Century AirCenter.

Existing Railroad Network

- Two BNSF mainline tracks of the Emporia Subdivision cross the study area as illustrated in Figure 2-3. *Mainline Track 1 (north track)* is located just south of, and generally parallel to, US 56 between Edgerton to Gardner.
- *Mainline Track 2 (south track)* runs parallel to Track 1, south of Edgerton and north of Gardner, but it diverges away from the north track through the middle of the study area. After crossing Nelson Street, it turns east along the south side of 199th Street to a point approximately 1 mile east of US 56, where it turns northeast, eventually rejoining Track 1 near Center Street.

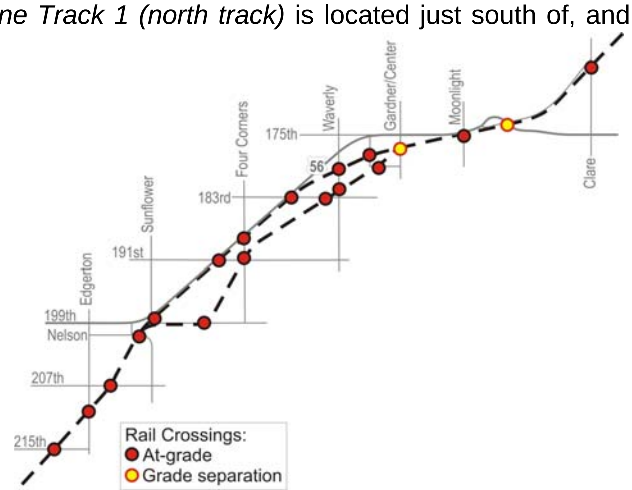


Figure 2-3: Gardner Area Highway-Rail Crossings

The traffic study area includes two grade-separated crossings at Center Street and at US 56 east of New Century Parkway. A third grade-separated crossing located at South Elm Street is currently closed. Thirteen at-grade crossings are located in the study area from Nelson Street to Moonlight Road as shown in Table 2-2. The at-grade crossings at Moonlight Road and Nelson Street include double tracks across the roadway. Table 2-2 lists the thirteen at-grade highway-rail crossings, their Department of Transportation (DOT) crossing numbers, daily train volume, Federal Railroad Administration (FRA) highway ADT estimate, milepost (MP) and track counts. Figure 2-3 shows the at-grade highway-rail crossings listed in Table 2-2.

Table 2-2: At-Grade Highway-Rail Crossings

Roadway	DOT Crossing #	Train Volume (2005)	Highway ADT (2005)	Milepost	Track
Moonlight Road	006162X	82	8,354	33.52	1 & 2
W. Grand Street	006170P	41	6	35.05	2
Poplar Road	006168N	41	64	35.06	1
Waverly Road 1	006178U	41	98	35.61X	1
Waverly Road 2	006172D	41	82	35.75	2
183rd Street	006179B	41	140	36.49X	1
183rd Street	006173K	41	150	35.97	2
Four Corners Road1	006180V	41	212	37.46X	1
Four Corners Road2	006175Y	41	224	37.59	2
191st Street	006181C	41	31	38.01X	1
199th Street 1	006176F	41	714	38.83	1
199th Street 2	006183R	41	767	39.04X	2
Nelson Street	006177M	82	1531	39.77X	1 & 2

<u>Existing Transportation Network Restrictions</u>

Non-passenger vehicles (such as commercial trucks) are prohibited from operating on roadways within the City of Gardner that are not designated as truck routes. This prohibition does not apply to vehicles that are picking-up or delivering at a residence, business, or construction site within the city, provided they take the most direct route to or from a designated truck route. Truck routes include Center Street, 183rd Street/Cherokee Street (west of Center Street), Madison Street, Main Street, Moonlight Road, Sycamore Street (Warren Street to Main Street), Warren Street, and 175th Street. A Kansas Highway Patrol (KHP) weigh station is located on I-35, north of 167th Street. KDOT and KHP are reportedly studying the potential relocation of this weigh station.

2.1.3 Crash History and Conditions

The crash analysis presented in Section 3.1 includes the two main highways in the study area: US 56 and I-35. Crash data were obtained from KDOT's Geometric and Accident Unit in May 2007 (KDOT, 2007). The data include all crashes reported on I-35 and US 56 during the five-year period from 2002 through 2006.

<u>Freeway/Roadway Section Crash Analysis</u>

I-35 and US 56 were subdivided into five smaller sections for the analysis, based on numbers of lanes, traffic volumes, and access control as shown in Table 2-3. Using the KDOT crash data, each of the five sections was examined in detail to highlight any trends or high crash rate locations. Crash totals were then summarized and stratified by severity, crash type, time of day, and roadway conditions to determine the presence of any crash patterns. Crash rates were also calculated for each section and compared to statewide averages.

Total Crashes

A total of 245 crashes occurred on I-35 between Sunflower Road and US 56 during the five-year analysis period. Approximately 64 percent of these crashes occurred between the I-35/Sunflower Road and I-35/Gardner Road interchanges. There were also five fatal crashes during the five-year period on I-35, four of which occurred between Sunflower Road and Gardner Road. A total of 382 crashes were reported on the section of US 56 between Edgerton Road and I-35 during the same time period. Most of these crashes occurred on the high-volume sections of US 56 from just west of downtown Gardner to the I-35 interchange. Only one fatal crash was reported on US 56 in the traffic study area during the 5-year period.

Table 2-3: Crash Summary and Crash Rates along I-35 and US 56

Roadway Section	Length (mi)	Avg. ADT (2002-06)	Crashes Total	Crashes Fatal	Crash Rate (per MVMT) Section Crash Rate	Statewide Average	KDOT Critical Rate[1] (99% conf)	Exceeds Critical Rate
I-35								
1. Sunflower to Gardner	4.714	22,256	156	4	0.815	0.640	0.792	YES
2. e/o Gardner to US 56	3.125	28,502	89	1	0.548	0.640	0.805	NO
US 56								
3. Edgerton to Warren	5.233	4,296	48	1	1.170	1.559	2.073	NO
4. e/o Warren to Cedar	1.475	12,952	148	0	4.245	5.729	6.788	NO
5. e/o Cedar to I-35	1.828	14,898	186	0	3.742	4.556	5.346	NO

Notes: ADT= Average Daily Traffic; MVMT= Million Vehicle Miles Traveled; KDOT= Kansas Department of Transportation.
[1]Critical Crash Rate = the rate that exceeds the statewide average rate at the confidence level specified.

Crash Rates

The Institute of Transportation Engineers (ITE) “Rate Quality Control Method” was employed to conduct a crash rate analysis for all five highway sections. This analysis compares the five-year average crash rate for a particular section to the statewide average for a similar type of highway. Statistical methods were then used to determine if the crash rate exceeds the statewide average (at a 99 percent confidence level) through the use of a critical crash rate threshold.

Table 2-3 shows the crash rates per million vehicle miles traveled (MVMT) for each of the five study highway sections. One section of I-35 between Sunflower Road and Gardner Road was found to exceed the critical crash rate threshold as shown on Table 2-3, indicating that it may be a high crash section. The other four all fall below both the critical threshold as well as the base statewide average for similar facilities. I-35 also had a high fatal crash rate between Sunflower Road and Gardner Road, exceeding the statewide average for fatal crashes. It is not conclusive why this section of I-35 has a higher crash rate, though the data analysis presented in Table 2-4 and in the following sections describes some differences in crash type, time, and roadway conditions.

Crash Severity

The crashes reported within each highway section were examined with respect to severity. Each crash was classified as either fatal, injury, or property damage only (PDO).

The majority of reported crashes were classified as PDO on both roadways (77 percent on I-35 and 74 percent on US 56). Approximately 21 percent of the crashes on I-35 and 26 percent of crashes on US 56 were injury crashes.

Of the total crashes that occurred along I-35, five were fatal crashes (one appeared to involve two fatalities). Four of these crashes occurred between Sunflower Road and Gardner Road, and one occurred between Gardner Road and US 56. During the 2002-2006 time frame, one fatal crash was reported on US 56 at the far western edge of the traffic study area.

Crash Type

An examination of the crash type data for I-35 reveals that the most common crash type was collision with an animal (29 percent). In the high crash rate section south of

Gardner, this type accounted for 31 percent of all crashes. The next most common crash type was collision with a fixed object (26 percent). Overall, crashes with animals and various objects accounted for 59 percent of all crashes on these sections of I-35. The third most common crash type was overturned (12 percent). The various categories of collisions with other vehicles (rear end, sideswipe, angle, etc.) accounted for approximately 23 percent of all I-35 crashes on the two segments evaluated.

Table 2-4: Crash Details along I-35 and US 56

	I-35			US 56				
	Sunflower to Gardner	e/o Gardner to US 56	Totals	Edgerton to Warren	e/o Warren to Cedar	e/o Cedar to I-35	Totals	Grand Totals
Stratified by Severity								
PDO	78%	76%	77%	73%	81%	69%	59%	66%
Injury	20%	22%	21%	25%	19%	31%	41%	33%
Fatality	3%	1%	2%	2%	0%	0%	0%	1%
Stratified by Type								
Other	54%	48%	52%	48%	5%	7%	8%	25%
Rear-End	10%	9%	10%	23%	36%	37%	17%	14%
Angle	3%	4%	3%	13%	44%	44%	19%	12%
Fixed Object	25%	28%	26%	13%	3%	8%	3%	12%
Sideswipe	8%	10%	9%	4%	12%	4%	5%	7%
Stratified by Time of Day								
12a - 7a	24%	25%	24%	19%	2%	7%	3%	11%
7a - 9a	13%	10%	12%	6%	10%	11%	5%	7%
9a - 4p	22%	24%	23%	21%	48%	37%	21%	22%
4p - 6p	10%	20%	13%	21%	20%	23%	10%	11%
6p - 12a	31%	21%	28%	33%	20%	23%	12%	18%
Stratified by Road Surface Condition								
Dry	67%	76%	70%	85%	86%	76%	44%	54%
Wet	10%	9%	9%	10%	12%	18%	6%	7%
Ice/Snow	15%	8%	13%	4%	1%	4%	1%	5%
Snow/Slush	8%	7%	7%	0%	1%	2%	0%	3%
Other/Unknown	0%	0%	0%	0%	0%	0%	0%	0%
Stratified by Contributing Circumstances								
Road/Veh Conds	54%	34%	47%	46%	3%	4%	7%	22%
Improper Maneuver	3%	7%	4%	15%	47%	41%	20%	14%
Animal	31%	24%	29%	35%	0%	1%	4%	14%
Inattentive Driver	8%	18%	11%	19%	26%	21%	13%	12%
Excessive Speed	15%	16%	15%	6%	3%	12%	2%	7%
Drugs/Alcohol	4%	13%	7%	4%	4%	4%	2%	4%
Other	9%	9%	9%	2%	1%	1%	1%	4%
Following Too Closely	3%	0%	2%	2%	10%	13%	4%	3%
Avoidance/Evasive Action	1%	3%	2%	2%	1%	2%	1%	1%

Angle and rear-end crashes accounted for over 80 percent of all crashes on the 4-lane section of US 56 between Gardner and I-35. Further, examination of the subdivided sections revealed that animal crashes accounted for the highest percentage (35 percent) on the western section, followed by rear-end crashes (23 percent). Angle and fixed-object crashes accounted for 13 percent each.

Time of Day

To examine time-of-day patterns, five time periods were established: a.m. off-peak (midnight to 7 a.m.), a.m. peak (7 to 9 a.m.), midday off-peak (9 a.m. to 4 p.m.), p.m. peak (4 to 6 p.m.), and pm off-peak (6 p.m. to midnight). The p.m. off-peak period was the most commonly reported time period for crashes on I-35 (28 percent), with 31 percent of all crashes on the southern segment occurring during that time period. The same was true for the easternmost segment of US 56, where 33 percent of all crashes occurred during the p.m. off-peak period. On the other US 56 segments studied, the most commonly reported period was the midday off-peak (9 a.m. to 4 p.m.), representing over 60 percent of all crashes on those two sections.

Road Surface Conditions

During the study period, dry roads constituted the most common road surface condition, representing 77 percent of total crashes along I-35 and US 56. Wet roadway conditions were present for 15 percent of US 56 crashes (9 percent for I-35), while ice and snow were present for 13 percent of I-35 crashes (3 percent for US 56).

Highway-Rail At-Grade Intersection Crash Analysis

There are currently 13 at-grade highway-rail grade crossings in the Gardner traffic study area from Nelson Street to Moonlight Road. Three are located near Edgerton, seven near the site of the Proposed Action, and three in the vicinity of Gardner as shown in Figure 2-3.

FRA compiles crash data from 1975 to the present for all at-grade rail crossings. It also assigns a crash prediction value, which represents the probability that a collision between a train and a highway vehicle will occur at a crossing in any given year. This value takes into account the crossing's physical and operating characteristics (i.e., ADT, total number of trains per day, number of tracks, maximum time table speed) and five years of crash history data at the crossing.

Table 2-5 presents the at-grade highway-rail crossing crash data and the corresponding prediction crash rate for the period of 2002 through 2006 (FRA, 2007). Between 2002 and 2006, one crash occurred at an at-grade crossing in the traffic study area. The fatality crash occurred at the Waverly Road crossing in 2006. The FRA prediction values for crashes at the locations in the study area range from a high of 0.0568 at Moonlight Road to a low of 0.0033 at 191st Street. Most of the values are below 0.02.

Table 2-5: At-Grade Highway-Rail Crossing Crash Summary

Roadway	DOT Crossing #	# of Crashes	Prediction Crash Rate
Moonlight Road	006162X	0	0.0568
Nelson Street	006177M	0	0.0417
Waverly Road	006172D	1 (2006, fatal)	0.0345
199th Street	006183R	0	0.0175
199th Street	006176F	0	0.0155
Four Corners Rd	006175Y	0	0.0117
Four Corners Rd	006180V	0	0.0115
W. Grand Street	006170P	0	0.0099
Poplar Street	006168N	0	0.0076
183rd Street	006179B	0	0.0057
183rd Street	006173K	0	0.0058
Waverly Road	006178U	0	0.0050
191st Street	006181C	0	0.0033

2.1.4 Existing Traffic Conditions

Existing traffic conditions in the traffic study area were assessed based on the current highway volumes, geometrics, and traffic control. The analysis presented below addresses traffic data collection, traffic volumes, traffic operations, and other key traffic issues. Detailed operational calculations are included in Appendix B.

Existing Traffic Data Collection
In order to accurately assess the current traffic conditions, the study team collected a wide range of traffic and highway data. This effort included collecting original field data as well as available existing data from various state and local agencies. Agencies that were contacted included KDOT, Mid-America Regional Council (MARC), Johnson County, Miami County, City of Gardner, and City of Edgerton. The following data were provided by the agencies:

- Detailed daily traffic counts for I-35 and US 56 including truck classification counts where available (KDOT)
- Average daily traffic estimates for over 40 other highway sections (KDOT count map)
- Traffic signal timing for signalized intersections (City of Gardner)
- Crash data for the traffic study area (KDOT)
- Recent traffic studies related to new developments and transportation improvements (various sources)

In addition, weekday a.m. and p.m. peak period intersection turning-movement counts were conducted at 29 study intersections, including the intersections at the three I-35 interchanges as well as 23 additional intersections within the traffic study area. The interchange counts were completed in June/July 2006, while the remaining counts were conducted in April/June 2007. The turning-movement counts were performed during the peak traffic periods of 7:00 to 9:00 a.m. and 4:00 to 6:00 p.m. In addition to the intersection counts, current intersection traffic control and geometry information was collected in the field. Observations were also made regarding current traffic operations at various locations such as the I-35 mainline and ramp termini. Current and forecasted train volumes were obtained from BNSF.

Current average daily traffic counts (from 2002 to 2007) were collected for most of the major roadways in the traffic study area. These counts were adjusted to a consistent base year of 2008.

Traffic Operations Analysis Methodology
The affected environment traffic analysis evaluated existing (2008) operating conditions at 27 study intersections as well as the freeway facilities (mainline and ramp) in the Gardner traffic study area. The analysis focused on the critical weekday a.m. and p.m. peak hours, although daily traffic volume data are presented where appropriate.

The Transportation Research Board's *Highway Capacity Manual* (HCM) method (Transportation Research Board, 2000) is the primary methodology resource used in the traffic operations analysis. The HCM method includes standard analysis methods for intersections, freeways, and ramps (merge and diverge).

Level of service (LOS) is the fundamental HCM parameter describing operational conditions within a traffic stream. LOS is an A-through-F letter ranking scale where LOS A indicates free-flow, low density, or minor delay conditions and LOS F indicates facility breakdown with low speeds, high densities, and high delay. For this study, since the surrounding land use is expected to urbanize during the study time horizon, a minimum standard of LOS D is used as the threshold for acceptable traffic operations. A facility operating below this threshold (at LOS E or F) is considered to be operating unacceptably. Additional details regarding LOS for both intersections and freeway facilities are provided in the methodology discussion in Appendix A.

Existing Intersection Operations

The existing conditions analysis was conducted for the weekday a.m. and p.m. peak hours using the existing traffic volumes, traffic control, and geometry for the study intersections, freeway sections, and freeway ramps. Operations at each of these facilities were examined to identify existing issues. Figure 2-4 illustrates the existing traffic control and geometry and Figure 2-5 illustrates the existing a.m. and p.m. peak-hour volumes used in the analysis. Existing peak hour truck percentages are presented in Appendix C.

Table 2-6 summarizes the results of the existing intersection operational analysis. As indicated in the table, the majority of the study intersections operate at LOS D or better during both peak hours. The following intersections, however, operate below this level:

- *Intersection #5: Moonlight Road and US 56.* This signalized intersection operates at LOS E during the p.m. peak hour, with an average delay of 73.2 seconds per vehicle (sec/veh). The heavy westbound through and right movements (1,373 vehicles combined) conflicting with the north-south flows are the main causes for this delay. In addition, the presence of the BNSF mainline tracks (100 feet to the south of the intersection) with the associated crossing signals, gates, and railroad pre-emption of the vehicular signals leads to additional delay and queuing when the south leg is blocked as discussed in Section 2.1.7.
- *Intersection #6: Old US 56 and US 56*. The northbound left approach to this unsignalized intersection operates at LOS E and F during the a.m. and p.m. peak hours, respectively, largely due to the heavy eastbound through movement in the a.m. peak (1,175 vehicles) and the heavy westbound through movement in the p.m. peak. (1,434 vehicles). Although the northbound approach operates below LOS D, it is a relatively low-volume approach. Approximately 50 and 120 vehicles approach the intersection from the south in the a.m. and p.m. peak hours, respectively.
- *Intersection #8: I-35 Southbound Ramps and US 56.* The one-lane I-35 southbound exit ramp flares to two lanes as it approaches US 56. The heavy southbound right-turn movement has a free-flow lane onto US 56 westbound. The southbound left-turn movement is stop-controlled. This southbound left-turn movement operates at LOS E during the p.m. peak hour, with a volume of 114 vehicles opposed by heavy eastbound and westbound through traffic totaling over 1,600 vehicles.
- *Intersection #10: Moonlight Road and Santa Fe Street.* This intersection is stop-controlled in the northbound and westbound directions. It is also just over 200 feet from the US 56/Moonlight Road intersection; both BNSF mainline tracks cross Moonlight Road between the two intersections. During the p.m. peak hour, the northbound approach to this intersection operates at LOS F due in part to a heavier flow of southbound traffic (approximately 550 vehicles), which does not stop. The short distance between the intersections and the added delay due to trains also affects the operating conditions at this intersection. These same factors also affect operations at the US 56/Moonlight Road intersection.
- *Intersection #15: Gardner Road and 183rd Street.* This intersection is stop-controlled in the eastbound and westbound directions. The westbound left-turn movement operates at LOS E in the a.m. peak hour with an average delay of 41 sec/veh. However, this is a relatively low-volume movement (41 vehicles during the a.m. peak hour; 88 during the p.m.).
- *Intersection #22: Gardner Road and I-35 NB Ramps.* The one-lane eastbound (off-ramp) approach to this unsignalized intersection operates at LOS F during the a.m. peak hour (average delay of 72 sec/veh). This is due, in part, to the conflicting southbound left and northbound right-turn movements, which are heaviest during the a.m. peak. While the level of service for this approach is below LOS D, the volume is modest at approximately 90 vehicles during the a.m. peak hour.

Table 2-6: Study Intersection Existing (2008) Capacity and Operations Analysis Summary					
Study Intersection # and Name	**Traffic Control**	**AM Peak Hour**		**PM Peak Hour**	
		Delay (sec/veh)	**LOS**	**Delay (sec/veh)**	**LOS**
1 Waverly Rd/ 175th St	TWSC	21.1 (SB)	C	13.5 (NB)	B
2 Gardner Rd/ US 56	Signalized	14.6	B	13.3	B
3 Elm/ US 56	Signalized	4.6	A	4.7	A
4 Mulberry/ US 56	Signalized	4.8	A	3.1	A
5 Moonlight Rd/ US 56	Signalized	35.4	D	**73.2**	**E**
6 Old US 56/ US 56	OWSC	**48.5 (NBL)**	**E**	**114.3 (NBL)**	**F**
7 Cedar Niles/ US 56	Signalized	20.9	C	20.6	C
8 US 56/ I-35 SB Ramps	OWSC	24.0 (SBL)[2]	C	**44.6 (SBL)[2]**	**E**
9 US 56/ I-35 NB Ramps	OWSC	20.4 (NB)	C	20.5 (NB)	C
10 Moonlight Rd/ Santa Fe	TWSC[1]	21.1 (NB)	C	**428.5 (NB)**	**F**
11 Waverly Rd/ US 56	TWSC	13.9 (NB)	B	11.9 (NB)	B
12 Four Corners/ 183rd St	AWSC	6.9	A	6.9	A
13 US 56/ 183rd St	TWSC	12.6 (WB)	B	12.3 (EB)	B
14 Waverly Rd/ 183rd St	TWSC	9.0 (SB)	A	8.8 (NB)	A
15 Gardner Rd/ 183rd St	TWSC	**41.3 (WBL)**	**E**	22.6 (WB)	C
16 Four Corners/ US 56	TWSC	11.9 (NB)	B	11.9 (NB)	B
17 US 56/ 191st St	TWSC	12.4 (EB)	B	12.4 (WB)	B
18 Four Corners/ 191st St	TWSC	8.4 (WB)	A	8.5 (WB)	A
19 Waverly Rd/ 191st St	TWSC	8.8 (NB)	A	8.7 (NB)	A
20 Gardner Rd/ W 191st St	OWSC	12.3 (EB)	B	13.3 (EB)	B
21 I-35 SB Ramps/ Gardner Rd	OWSC	13.5 (WB)	B	28 (WB)	D
22 I-35 NB Ramps/ Gardner Rd	OWSC	**72.3 (EB)**	**F**	22.4 (EB)	C
23 Gardner Rd/ E 191st St	OWSC	9.9 (WB)	A	9.0 (WB)	A
24 US 56/ Sunflower Rd	TWSC	13.7 (NB)	B	12.9 (NB)	B
25 US 56/ E 4th St	OWSC	12.3 (NB)	B	12.7 (NB)	B
26 Four Corners Rd/ 199th St	OWSC	9.1 (SB)	A	8.9 (SB)	A
27 Gardner Rd/ 199th St	AWSC	9.0	A	9.1	A

Notes: TWSC – Two-way STOP control, OWSC – One-way STOP control, AWSC – All-way STOP control, LOS – Level of Service.
For one and two-way STOP-controlled intersections the delay and LOS for the worst approach is shown.
Bold indicates a LOS below the acceptable threshold.
[1] The east and south legs are STOP controlled.
[2] The southbound right movement is treated as free flow.

Figure 2-4: Study Area Existing Lane Configuration and Traffic Control

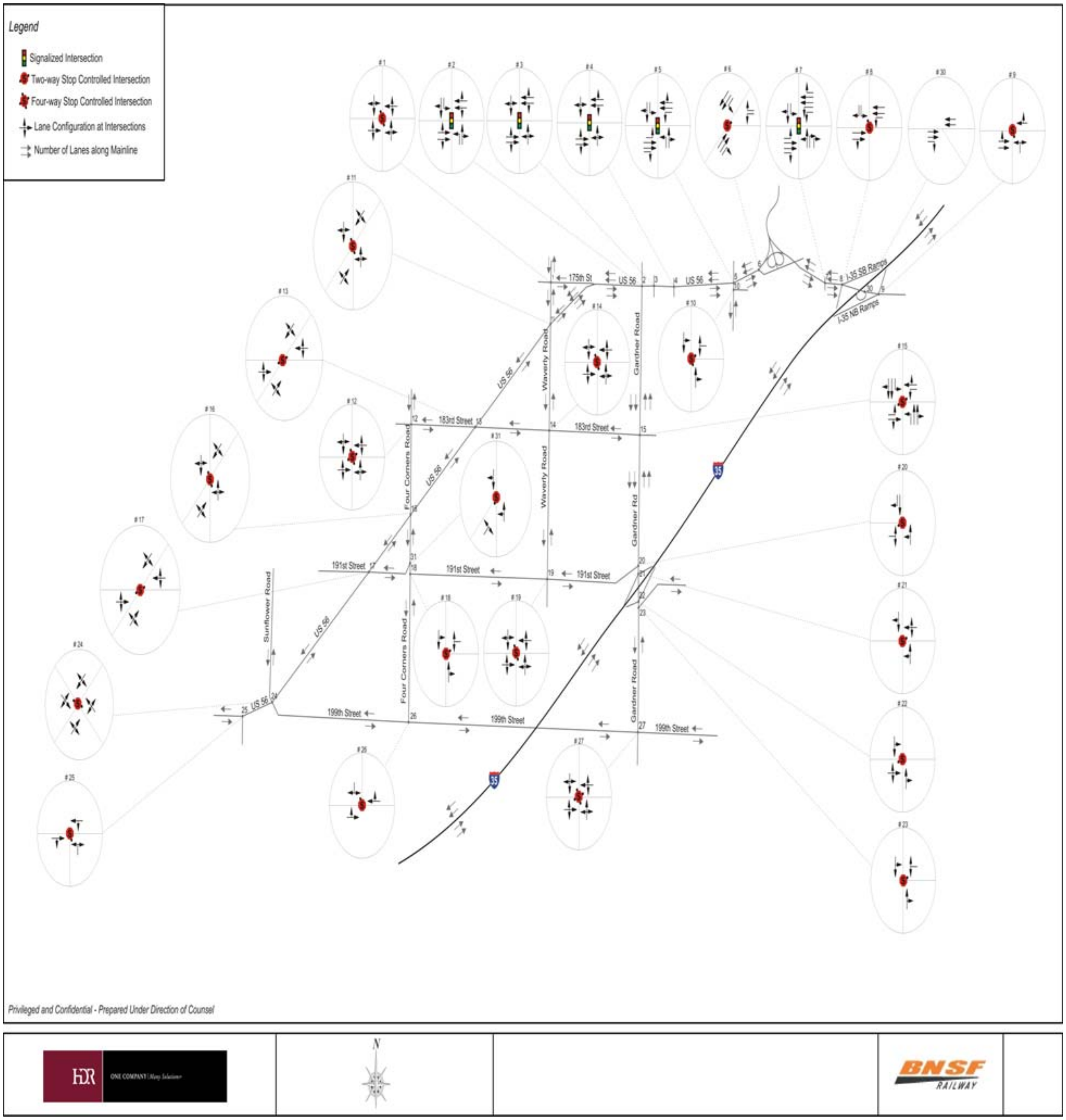
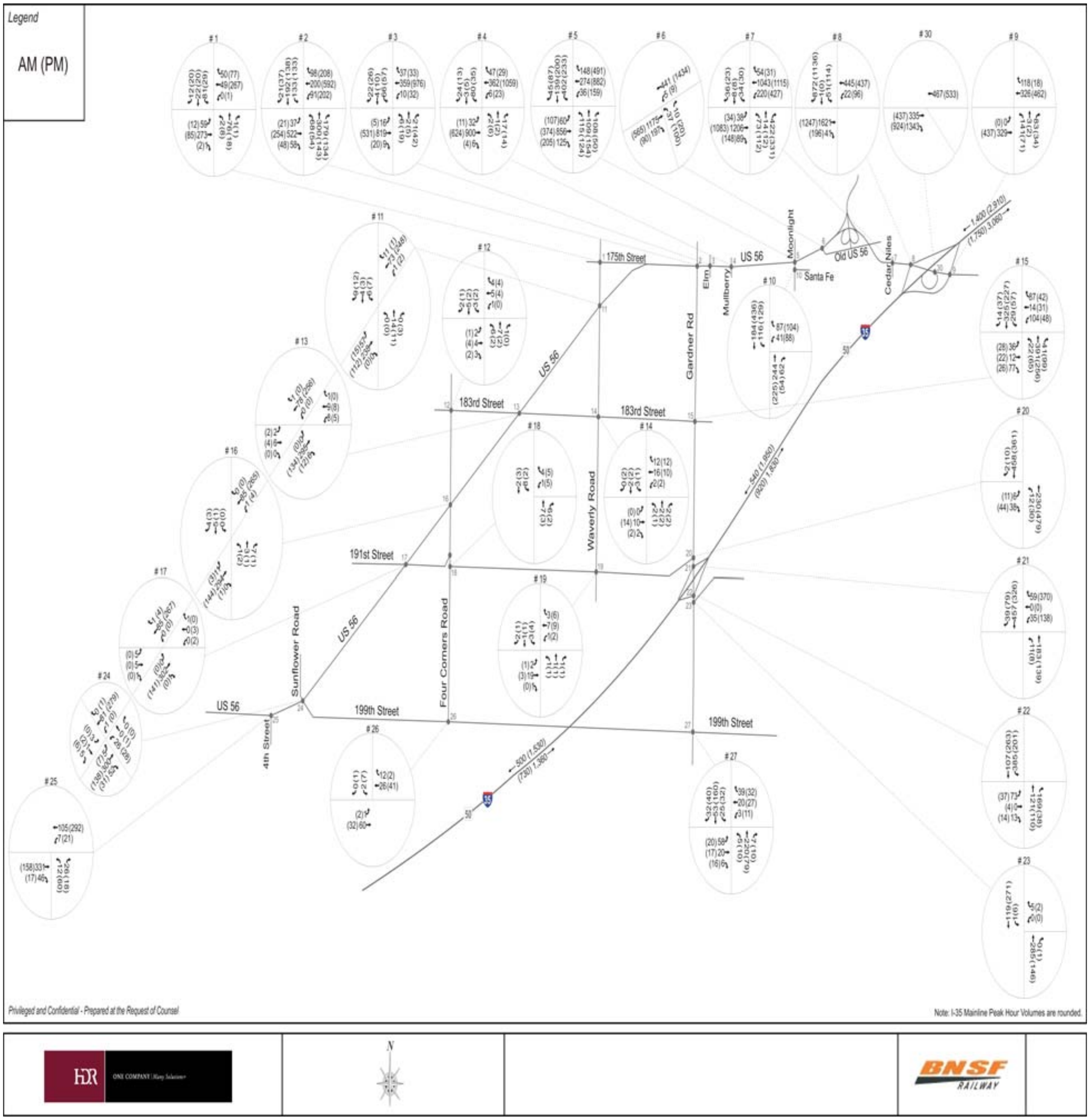


Figure 2-5: Existing (2008) Peak Hour Turning Movement Volumes



Existing Freeway Operations

The existing I-35 freeway operational analysis (for both mainline and ramp junctions) is summarized in Table 2-7. Currently all freeway segments and ramps in the traffic study area operate at an acceptable LOS (i.e., C or better). Only one freeway segment operates at LOS C (US 56 to 151st Street), while all of the others operate at LOS A or B during both peak periods. Similarly, all of the ramps at the three interchanges in the traffic study area operate at LOS B or better, with the exception of the US 56 on-ramps to I-35 northbound in the a.m. peak and the US 56 southbound off-ramp in the p.m. peak (which operate at LOS C).

Table 2-7: Existing (2008) Freeway Operational Analyses

	AM Peak Hour Density (pc/mi/ln)	AM Peak Hour LOS	PM Peak Hour Density (pc/mi/ln)	PM Peak Hour LOS
Basic Freeway Segments				
I-35 NB				
Sunflower to Gardner	11.2	B	6.3	A
Gardner to US 56	15.2	B	7.9	A
US 56 to 151st Street	25.6	C	14.5	B
I-35 SB				
151st St to US 56	11.7	B	24.2	C
US 56 to Gardner	4.7	A	16.2	B
Gardner to Sunflower	4.3	A	12.8	B
Ramp Junctions				
I-35 NB				
Gardner Off	10.6	B	4.7	A
Gardner On	16.6	B	9.0	A
US 56 Off	15.1	B	6.5	A
US 56 On	26.5	C	15.6	B
Loop Ramp On	27.9	C	17.8	B
I-35 SB				
US 56 Exit	11.0	B	25.8	C
US 56 Entr	5.4	A	17.8	B
Gardner Exit	2.7	A	16.5	B
Gardner Entr	5.5	A	14.3	B

Notes: pc/mi/ln – passenger cars per mile per lane, LOS – Level of Service.

2.1.5 Transit

Currently, there is no transit service in the immediate vicinity of the Gardner site. However, transit service in the Gardner area is provided by Johnson County Transit (The JO), as illustrated in Figure 2-6. The main route serving Gardner is Route L (Johnson County Transit, 2008). This is a weekday peak-period express route between the downtown Gardner area and Kansas City, Missouri, with stops at two park-and-ride lots along I-35 north of Gardner. It accesses I-35 via the US 56 interchange. Route L provides three northbound runs to Kansas City in the a.m. peak and three southbound runs from Kansas City in the p.m. peak. The L/N Route also serves the same area with a single late afternoon southbound run from Kansas City each weekday.

Figure 2-6:
Johnson County Transit Route L

2.1.6 Pedestrian and Bicycle Facilities

The roads adjacent to the project area are gravel and do not include specific bicycle or pedestrian facilities. However, there are sidewalks on Gardner Road and on the short new portion of 188th Street just west of Gardner Road. This includes a wide arterial pathway on the east side of Gardner Road from near 191st Street north to West Grand Street.

2.1.7 At-Grade Rail-Highway Crossings and Delay

Table 2-8 highlights 9 key roadways with at-grade highway-rail crossings between Gardner and Edgerton. For each of these crossings, average blocked times and vehicular delays during the a.m. and p.m. peak hours were estimated for the existing train and highway volume conditions (locations where the tracks are separate, such as on 191st Street were treated as one generalized crossing for calculation purposes).

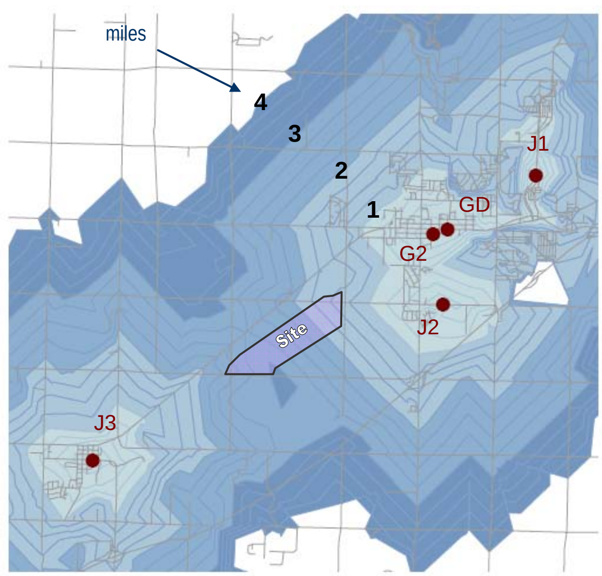
Table 2-8: Gardner Existing Train Crossing Data

		Vehicular Traffic Volume (veh/hr)				Avg. Blocked Crossing Time During Hour (min)		Avg. Delay Per Vehicle (sec)			
		All Vehicles		Vehicles Delayed by Trains				All Vehicles		Delayed Vehicles Only	
Mile		AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
33.52	Moonlight Rd	632	893	96	145	8.2	8.2	13	14	88	87
35.61	Waverly Rd	19	19	3	3	8.2	8.2	12	12	89	89
36.49	183rd St	30	29	4	4	8.2	8.2	12	12	88	87
37.46	Four Corners Rd	12	9	2	1	8.2	8.2	12	12	90	87
38.01	191st St	7	5	1	1	8.2	8.2	12	12	86	90
39.4	199th St	80	62	11	9	8.2	8.2	12	12	87	87
39.77	Nelson St	142	169	21	24	8.2	8.2	13	13	86	88
40.7	207th St	108	108	16	15	8.2	8.2	13	13	86	89
41.2	Edgerton Rd	6	9	1	1	8.2	8.2	12	12	88	87

Approximately 69 trains currently pass through Gardner on the BNSF mainline on an average weekday (Tuesday – Thursday). These trains do not run on fixed schedules; rather, they arrive at various times throughout the 24-hour period. Given the average train length and speed data for this section of track, the average blocked time per train is just under three minutes (this includes gate time before and after each train). Assuming a roughly uniform arrival pattern, the typical average blocked time per hour at each crossing location is approximately eight minutes on an average weekday.

The average delay for all vehicles at each crossing during the a.m. or p.m. peak hours is approximately 12 to 14 sec/veh. The average delay for vehicles that are present when a train is crossing during the a.m. or p.m. peak hours is approximately 86 to 90 seconds per delayed vehicle (approximately one and a half minutes per vehicle). These calculations assume uniform train and highway vehicle arrivals.

Figure 2-7:
Distance from Emergency Response



2.1.8 Emergency Vehicle Access

There are currently two primary entities that provide fire and rescue services in the vicinity of the Gardner site: Johnson County Fire District (FD) No. 1 and Gardner Public Safety Department. Johnson County FD No. 1 serves Southwestern Johnson

County including the City of Edgerton and the unincorporated areas surrounding Edgerton and Gardner. The Gardner Public Safety Department serves the City of Gardner. These two agencies also have a standing inter-agency agreement whereby they support each other in certain circumstances. They also partner with Johnson County Med-Act to provide advanced medical response services. Together, the two local agencies operate a total of five fire/rescue stations in the Gardner/Edgerton area. These stations are listed below and shown in Figure 2-7.

1. Johnson Co. FD No. 1 Station #1 (490 New Century Pkwy – 4 response vehicles) [J1]
2. Johnson Co. FD1 Station #2 (234 East Park Street in Gardner – 3 response vehicles) [J2]
3. Johnson Co. FD1 Station #3 (400 E. 3rd Street in Edgerton – 3 response vehicles) [J3]
4. Gardner Plum Creek Station #2 (29000 E. 183rd Street – 3 response vehicles), opened Feb. ‘08 [G2]
5. Gardner Department of Public Safety (400 E. Main Street) [GD]

Figure 2-8:
Gardner Area Highway Classifications

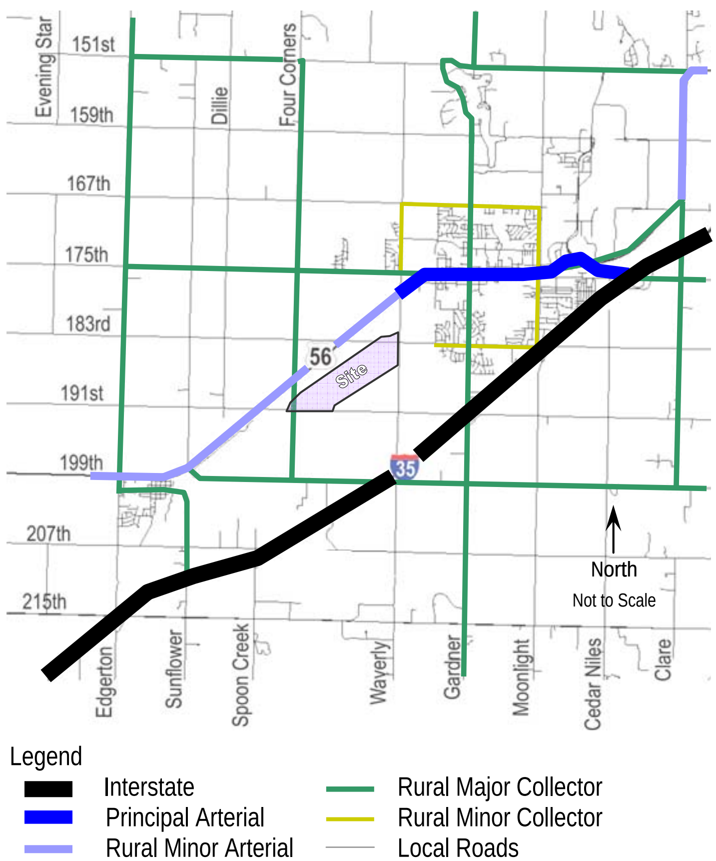


Figure 2-7 shows one, two, three, and four-mile bands around the above five stations. The bands are based on the local roadway network and therefore show actual travel distances from the stations to various areas. From Figure 2-7, it is apparent that the area around the Gardner site is within 4 miles of one or more fire/rescue stations.

Emergency vehicle responders have the potential of being delayed if a train is present at the mainline crossing. The actual delay time would depend entirely on the specific conditions (i.e., emergency vehicle arrival time relative to the train arrival time as well as the length and speed of the train). However, the total blocked-time delay due to a single train, based on the average speed data provided by BNSF, is approximately 2.2 minutes (excluding flashing light and gate time).[1] Currently, the Gardner-based stations can serve both sides of the track without additional delay by using the Center Street Bridge. Emergency responders from the Edgerton station to the south and southwestern Gardner areas must cross the BNSF tracks at-grade to reach the areas east of US 56 unless they go substantially out of their way to Center Street in Gardner.

[1] This is the average time a train blocks this crossing, not the average delay for vehicles, as not all vehicles are blocked the total time the train occupies the crossing.

2.1.9 Circulation System

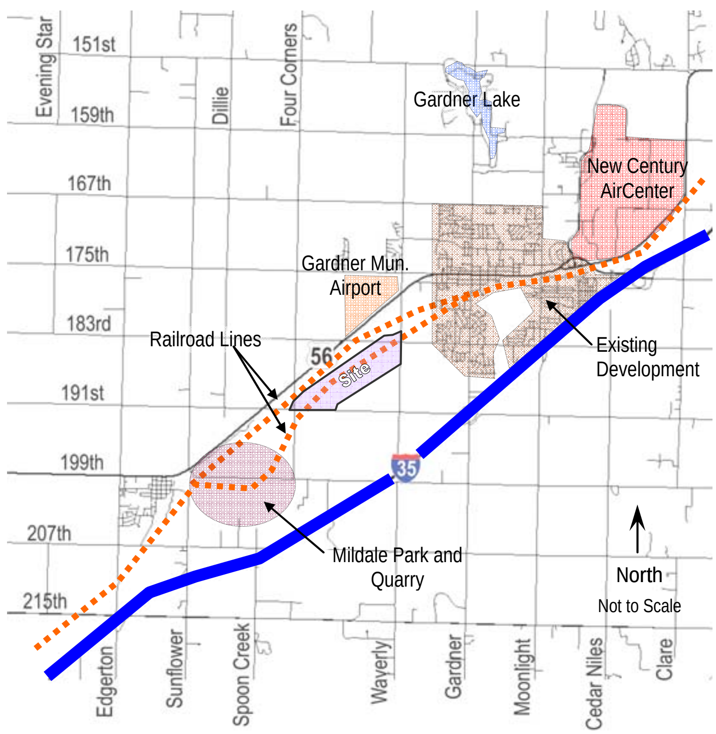
There are three major subtopics related to the existing local highway circulation system in the vicinity of the Gardner site: system form, connectivity, and barriers.

The circulation system in the vicinity of the Proposed Action is generally a grid system as shown in Figure 2-8. The grid spacing is approximately one mile between roadways in the undeveloped areas. In the developed portions of Gardner and Edgerton, there is a combination of tight grid network (older development) and curvilinear roadways with cul-de-sacs (newer development). US 56 and I-35 both cut through the grid system at an angle, but because I-35 has access only at interchanges it provides regional, but not local, connectivity.

The current roadway hierarchy has been developed such that arterial and collector roadways carry higher local traffic volumes and essentially serve as the backbone of the local system. These higher classification facilities, combined with the remaining grid system, provide local network connectivity, including connections to I-35 - which, in turn, provides the major connection to the larger region.

Based on KDOT's and MARC's most recently published highway classification information, US 56 is classified as an arterial highway - Principal Arterial in Gardner and Minor Arterial west of Gardner. Gardner Road/Center Street and 199th Street (east of US 56) are both classified as Rural Major Collectors. Four Corners Road and 175th Street (west of US 56) are also classified as Rural Major Collectors. The remaining roadways are unclassified in MARC's current hierarchy. However, as a practical consideration portions of Moonlight Road, 183rd Street, and 167th Street could be classified as Rural Minor Collectors. The remaining road-ways would then be classified (at present) as Local Roadways.

Figure 2-9:
Gardner Area Barriers to Local Transportation



The transportation system barriers addressed in this report are physical features (natural or man-made) that block or inhibit new connections between local transportation facilities. For example, a creek is a natural transportation barrier. Connecting roadways on different sides of a creek requires the construction of a bridge or culvert. Some of the current highway system barriers include I-35, existing development, railroad lines, New Century AirCenter, Mildale Park, Gardner Municipal Airport, and local creeks and streams. A number of these are shown in Figure 2-9. These barriers are penetrated to various extents (for example there are many railroad and stream crossings), but each could be a barrier to future highway system development.

2.2 Wellsville North Alternative

2.2.1 Wellsville North Traffic Study Area

Figure 2-10: Wellsville North Alternative Site Vicinity

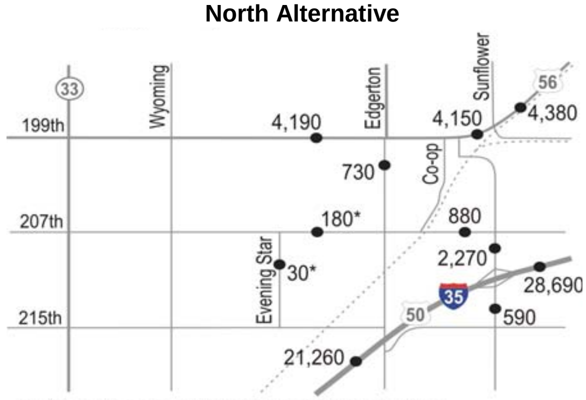
The Wellsville North site is located to the west of Edgerton Road to nearly Wyoming Road; and north of I-35 and the BNSF mainline to approximately ¼ mile north of 215th Street as shown in Figure 2-10. The project site is situated to the southwest of the City of Edgerton and northeast of Wellsville in unincorporated Johnson County and Miami County. A traffic study area surrounding the site was defined and analyzed for potential traffic impacts. The Wellsville North traffic study area is generally bounded by Kansas Highway 33 (K-33) to the west, 223rd Street to the south, Gardner Road to the east, and 175th Street to the north.

While the traffic study area was the geographic focus for data collection, travel demand forecasting, and traffic operations analysis, this analysis focused on major roadways and minor roadways expected to carry project-related traffic.

As in the analysis of the Proposed Action, a larger area was considered in developing regional assumptions regarding truck distribution patterns associated with the Wellsville North Alternative. This larger area considered the freeway and interstate system of the entire Kansas City metropolitan area to the extent appropriate.

2.2.2 Existing Transportation Network in the Wellsville North Alternative Vicinity

Figure 2-11: Existing ADTs –Vicinity of Wellsville North Alternative

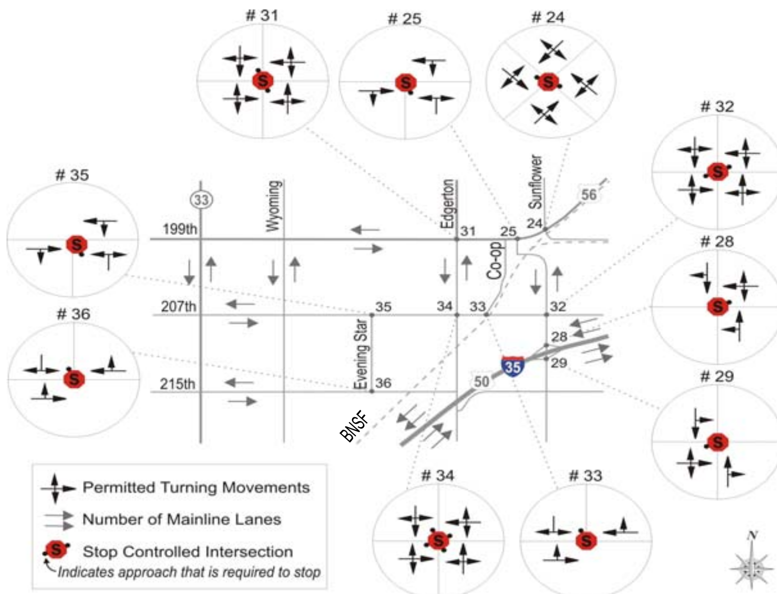


*Estimated based on existing turning movement counts

The Wellsville North traffic study area includes the roadways in the Gardner study area plus the additional highway facilities listed below, presented in decreasing order of functional classification. Figure 2-11 contains the existing ADT volumes in the Wellsville North study area. Figure 2-12 illustrates the existing roadway network geometry and traffic controls at the Wellsville North study intersections (except intersections 1, 2, 11, 13, 16, 17, and 26 which were presented in Figure 2-4).

- *I-35* is a 4-lane interstate highway running northeast-southwest through the study area. It has a posted speed limit of 70 mph. I-35 carries approximately 21,000 to 29,000 vpd in the study area.

Figure 2-12: Existing Geometry and Traffic Control – Wellsville North Alternative



- *US Route 56 (US 56)/199th Street* is a two-lane highway, with a posted speed varying between 45 mph and 55 mph, and 2008 volumes of 4,400 vpd or lower. The portion of US 56 that is included in the Wellsville North study area extends from approximately K-33 in the southwest to Center Street/Gardner Road in the northeast.
- *Sunflower Road* is a two-lane paved collector providing the primary north-south connection between the City of Edgerton and I-35. Sunflower Road curves and becomes Nelson Road within the City. Sunflower Road/Nelson Road has one of the two at-grade railroad crossings in the Edgerton area. Traffic volumes on Sunflower Road are lower than 2,300 vpd depending on location.
- *Edgerton Road (West 8th Street in Edgerton)* is a two-lane paved collector north of 207th Street, and a gravel roadway south of 207th Street. Edgerton Road provides the secondary north-south connection between US 56 and 207th Street, giving access to the community on the west side of Edgerton. To the south of 207th Street, Edgerton Road crosses the BNSF railroad tracks. Edgerton Road carries approximately 700 vpd within the study area.
- *207th Street* is a two-lane paved local road running east-west through the study area. An at-grade rail crossing exists on 207th Street between Edgerton Road and Sunflower Road. This roadway provides access to I-35 for residents in the western part of Edgerton. Volumes on 207th Street range from 180 to 880 vpd depending on location.
- *215th Street* is an east-west two-lane gravel road. There is currently an at-grade rail crossing on 215th Street between Evening Star Road and Edgerton Road. This roadway serves agriculture/undeveloped land.
- *Evening Star Road* is a north-south two-lane gravel roadway connecting 207th Street and 215th Street. Existing daily volumes are very low, as shown in Figure 2-11.
- *Co-op Road (East 2nd Street in Edgerton)* is a two-lane paved local roadway running along the southeastern portion of the City of Edgerton, paralleling the BNSF railroad. This roadway serves some local homes and the Ottawa Cooperative Association grain elevator.

The Wellsville North analysis also evaluated the I-35/Sunflower Road interchange that was not included in the Gardner analysis. However, the I-35/K-33 interchange, which is located approximately five miles southwest of the I-35/Sunflower Road interchange, was not included in the Wellsville North analysis. The K-33 interchange provides access to the City of Wellsville to the north and to the City of Rantoul approximately 12 miles to the south. This interchange was not evaluated because little to no project traffic is anticipated to use it.

2.2.3 Wellsville North Existing Conditions Analysis

The existing conditions analysis was conducted in a manner similar to the Gardner analysis utilizing the existing traffic volumes, traffic control, and geometry to analyze the study intersections, freeway sections, and freeway ramps. The general overall operations at each of these transportation facilities were examined for deficiencies. Figure 2-13 illustrates the existing a.m. and p.m. peak-hour volumes used in the analysis (except intersections 1, 2, 11, 13, 16, 17, and 26 which were presented in Figure 2-5). Existing peak-hour truck percentages are presented in Appendix C, and detailed operational results are included in Appendix D.

Existing Intersection Operations

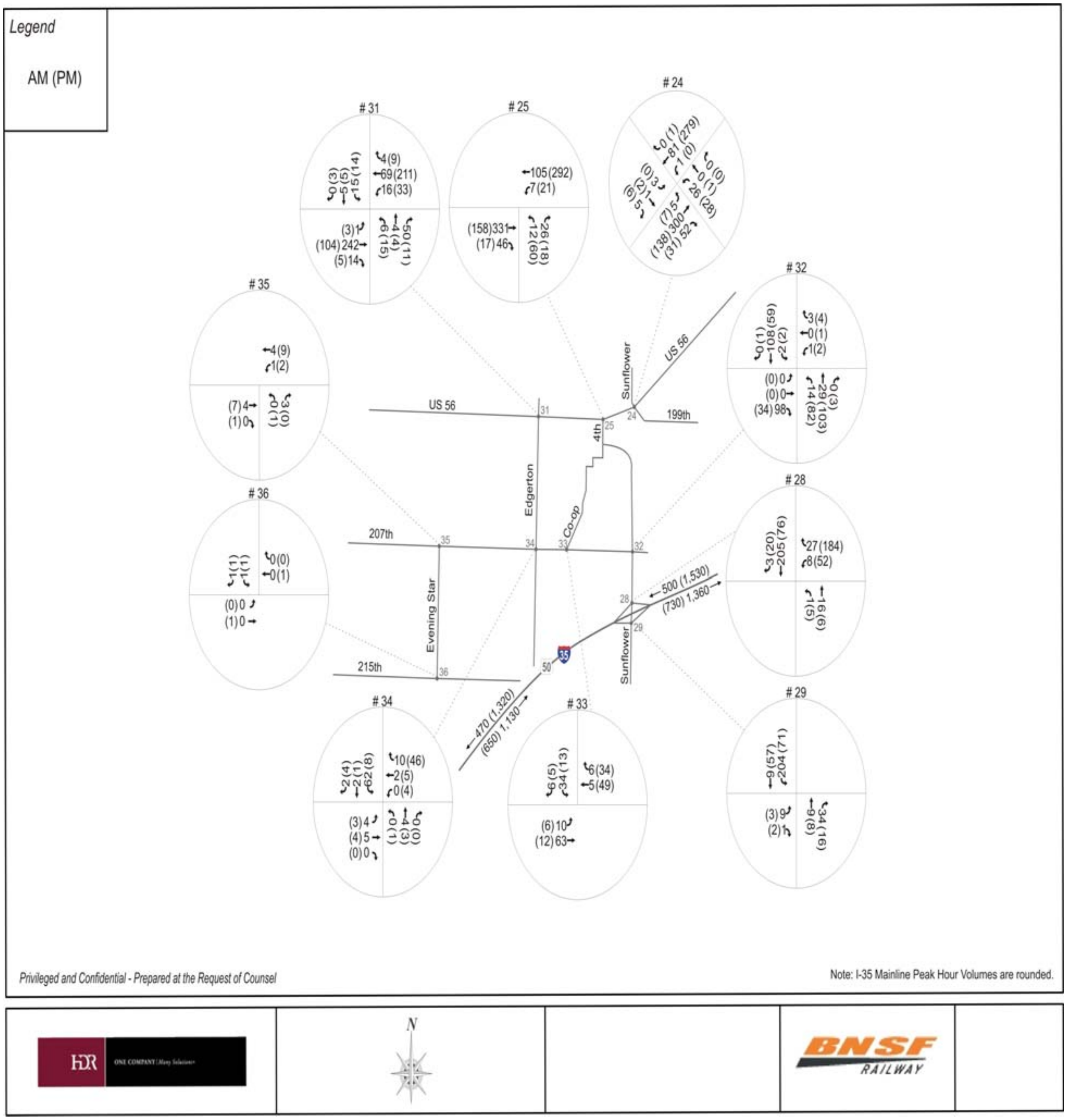
Table 2-9 summarizes the results of the existing intersection analysis for the Wellsville North Alternative. The study intersections generally carry low volumes and are mainly unsignalized. Most of the study intersections currently operate at LOS C or better during the both peak hours. The one exception is the unsignalized intersection of US 56 and the Southbound I-35 Ramps. At this intersection, the one-lane I-35 southbound exit ramp flares to two lanes as it approaches US 56. The heavy southbound right-turn movement has a free-flow lane onto US 56 westbound. The southbound left-turn movement is stop-controlled. This southbound left-turn movement operates at LOS E during the p.m. peak hour, with a volume of 114 vehicles opposed by heavy eastbound and westbound through traffic totaling over 1,600 vehicles.

Table 2-9: Wellsville North Study Intersection Existing (2008) Capacity and Operations Analysis Summary

Study Intersection # and Name	Traffic Control	AM Peak Hour Delay (sec/veh)	AM Peak Hour LOS	PM Peak Hour Delay (sec/veh)	PM Peak Hour LOS
1 175th St/ Waverly Rd	TWSC	21.1 (SB)	C	13.5 (NB)	B
2 US 56/ Gardner Rd	Signalized	14.6	B	13.3	B
8 I-35 SB Ramps/ US 56	OWSC	24.0 (SBL)[1]	C	**44.6 (SBL)[1]**	**E**
9 I-35 NB Ramps/ US 56	OWSC	20.4 (NB)	C	20.5 (NB)	C
11 US 56/ Waverly Rd	TWSC	13.9 (NB)	B	11.9 (NB)	B
13 183rd St/ US 56	TWSC	12.6 (WB)	B	12.3 (EB)	B
16 US 56/ Four Corners Rd	TWSC	11.9 (NB)	B	11.9 (NB)	B
17 191st St/ US 56	TWSC	12.4 (EB)	B	12.4 (WB)	B
24 US 56/ Sunflower Rd	TWSC	13.7 (NB)	B	12.9 (NB)	B
25 US 56/ E 4th St	OWSC	12.3 (NB)	B	12.7 (NB)	B
28 I-35 SB Ramps & Sunflower Road	OWSC	9.0 (WB)	A	9.8 (WB)	A
29 I-35 NB Ramps & Sunflower Road	OWSC	13.6 (EB)	B	9.6 (EB)	A
31 199th & Edgerton	TWSC	12.6 (SB)	B	12.5 (SB)	B
32 207th & Sunflower	TWSC	9.6 (WB)	A	10.2 (WB)	B
33 207th & Co-op Road	OWSC	9.3 (SB)	A	9.2 (SB)	A
34 207th & Edgerton	AWSC	7.6	A	6.9	A
35 207th & Evening Star	OWSC	8.4 (NB)	A	8.5 (NB)	A
36 215th & Evening Star	OWSC	8.4 (SB)	A	8.4 (SB)	A

Notes: TWSC – Two-way STOP control, OWSC – One-way STOP control, AWSC – All-way STOP control, LOS – Level of Service.
Bold indicates a LOS below the acceptable threshold.
For one and two-way STOP-controlled intersections the delay and LOS for the worst approach is shown.
[1] The southbound right movement is treated as free flow.

Figure 2-13: Wellsville North Study Intersection Peak Hour Turning Movement Volumes



Existing Freeway Operations

In addition to the Gardner area freeway facilities described in Section 2.1.2, the analysis for the Wellsville North Alternative evaluated the I-35 mainline south of Sunflower Road as well as the I-35/Sunflower Road interchange ramps. As shown in Table 2-10 these additional freeway facilities all currently operate at LOS B or better.

Table 2-10: Existing (2008) Freeway Operational Analyses

	AM Peak Hour Density (pc/mi/ln)	AM Peak Hour LOS	PM Peak Hour Density (pc/mi/ln)	PM Peak Hour LOS
Basic Freeway Segments				
I-35 NB				
Edgerton to Sunflower	9.4	A	5.7	A
I-35 SB				
Sunflower to Edgerton	4.1	A	11.1	A
Ramp Junctions				
I-35 NB				
Sunflower Off	8.3	A	3.9	A
Sunflower On	12.6	B	7.4	A
I-35 SB				
Sunflower Exit	2.3	A	12.5	B
Sunflower Entr	4.9	A	12.5	B

Notes: pc/mi/ln – passenger cars per mile per lane, LOS – Level of Service.

Existing Railroad Network

Throughout the Wellsville North study area there are a number of rail crossings. These at-grade rail crossings generally include two parallel mainline tracks and are mostly located on low-volume gravel roads. The locations and alignments of the two mainline tracks are discussed in *Existing Railroad Network*, Section 2.1.2.

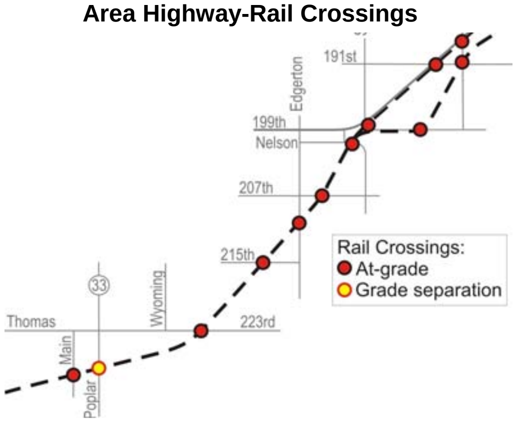
The Wellsville North traffic study area includes one grade-separated crossing on K-33 south of East 7th Street in Wellsville. There are seven at-grade crossings (five of which include double tracks across the roadway), from 223rd Street to 199th Street. Table 2-11 lists the seven at-grade highway-rail crossings, their DOT crossing numbers, daily train volume, FRA highway-ADT estimate, MP, and track. Figure 2-14 illustrates the at-grade highway-rail intersections included in Table 2-11.

Table 2-11: Wellsville North Study Area At-Grade Highway-Rail Crossings

Roadway	DOT Crossing #	Train Volume (2005)	Highway ADT (2005)	Milepost	Track
199th St 1	006176F	41	714	38.83	1
199th St 2	006183R	41	767	39.04X	2
Nelson St	006177M	82	1531	39.77X	1 & 2
207th Street	006184X	82	936	40.70	1 & 2
Edgerton Rd	006185E	82	127	41.20	1 & 2
215th Street	006187T	82	27	42.03	1 & 2
223rd Street	006190B	82	72	43.39	1 & 2

Source: FRA, 2005.

Figure 2-14: Wellsville North Study Area Highway-Rail Crossings



Highway-Rail At-Grade Intersection Crash Analysis

As with the Gardner analysis, the Wellsville North crash analysis uses FRA crash data and prediction values. Between 2003 and 2007, three crashes occurred at at-grade crossings in the Wellsville North study area. The 223rd Street crossing involved an injury while the other 207th Street crashes were PDO. Table 2-12 presents the at-grade rail crossing crash data for 2003 through 2007 as well as the corresponding prediction crash rate (FRA, 2008). The prediction values for crashes at the locations in the study area range from a high of 0.3492 at 207th Street to a low of 0.0054 at 215th Street.

Table 2-12: Wellsville North At-Grade Highway-Rail Crossing Crash Summary

Roadway	DOT Crossing #	# of Crashes	Prediction Crash Rate
207th Street	006184X	2 (2003 PDO, 2007 PDO)[1]	0.3492
Edgerton Road	006185E	0	0.2321
215th Street	006187T	0	0.0054
223rd Street	006190B	1 (2004 Injury)	0.0194

Notes:
[1] PDO means Property Damage Only.

2.2.4 Transit

Currently, there are no transit services in the immediate vicinity of the Wellsville North Alternative, the City of Edgerton, or the City of Wellsville.

2.2.5 Pedestrian and Bicycle Facilities

The roads adjacent to the project site are gravel and do not include specific provisions for either bicycles or pedestrians. The paved roads providing access to the site are rural roads also without specific provisions for bicycles or pedestrians.

2.2.6 At-Grade Rail-Highway Crossings and Delay

The current blocked time and crossing delay described previously for the Edgerton area locations also applies to Wellsville North. In addition, there are three crossings in Wellsville presented in Table 2-13. As with the Edgerton area data, the average blocked time per train is just under three minutes (including flashing light and gate time). Approximately eight minutes per hour are blocked on average during a typical weekday. The average delay per vehicle is 12 to 13 seconds for all vehicles and 86 to 88 for delayed vehicles.

Table 2-13: Additional Wellsville North Existing Crossing Data

		Vehicular Traffic Volume (veh/hr)				Avg. Blocked Crossing Time During Hour (min)		Avg. Delay Per Vehicle (sec)			
		All Vehicles		Vehicles Delayed by Trains				All Vehicles		Delayed Vehicles Only	
Mile		AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
42.03	215th	1	3	0	0	8.2	8.2	12	12	85	87
43.39	223rd	8	9	1	1	8.2	8.2	12	12	88	88
45.45	Main	166	185	24	27	8.2	8.2	13	13	88	88

2.2.7 Emergency Vehicle Access

Two primary entities provide fire and rescue service in the vicinity of the Wellsville North Alternative. The first is the Wellsville Fire Department, which has an agreement with Miami County FD No. 1 to provide service in Miami County near Wellsville. The second is Johnson County FD No. 1 Station #3 in Edgerton. The two stations are located at:

1. Wellsville Fire Station (730 S. Main Street) [W]
2. Johnson Co. FD1 Station #3 (400 E. 3rd Street in Edgerton) [J3]

Figure 2-15: Distance from Emergency Response

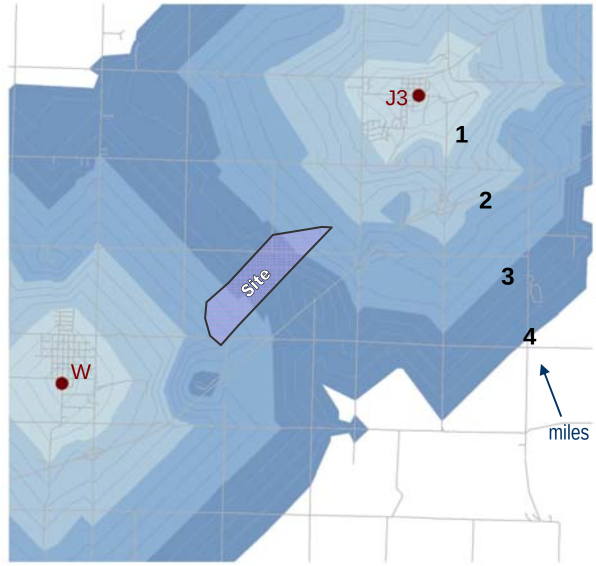
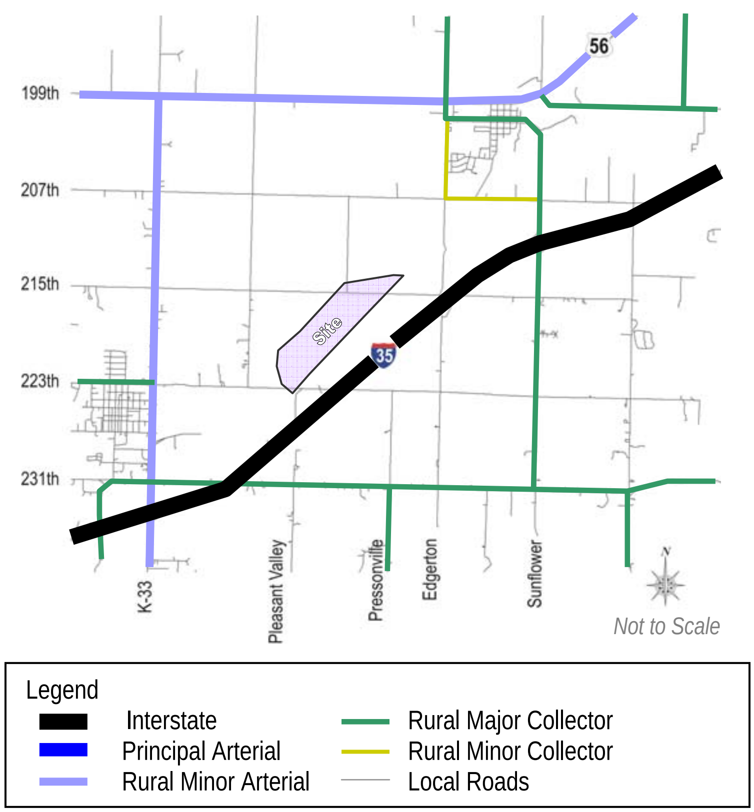


Figure 2-15 illustrates service distance bands (from 1 to 4 miles) around the two stations. The Wellsville North site is within four miles of one or both of the two stations.

Similar to Gardner, emergency vehicle responders have the potential of being delayed if a train is present at a crossing. The actual delay time would depend on the specific conditions (i.e., emergency vehicle arrival time relative to the train arrival time as well as the length and speed of the train). However, the total blocked-time delay due to a single train, based on the average speed data provided by BNSF, is approximately 2.2 minutes (excluding flashing light and gate time). Currently, the Wellsville-based station is the only station that can serve both sides of the tracks without additional delay by using the Poplar Street bridge. Responders from the Edgerton station must cross the BNSF tracks at-grade to reach the areas east of the tracks.

Figure 2-16: Wellsville North Area Highway Classifications



2.2.8 Circulation System

The area around the Wellsville North Alternative project site has many similarities to the Gardner project site vicinity in terms of highway form, connectivity, and barriers. The Wellsville North Alternative project site is located within a rural grid system with approximately 1-mile spacing between roadways. In the vicinity of Edgerton, there is an older, denser highway grid near the center of town as well as more recent curvilinear roadways to the west and south of town. Figure 2-16 illustrates the circulation system in this area.

Major local connectivity in the area is provided by a set of arterial and collector roadways. The MARC classification system ends at the Johnson County border and the classification information for the surrounding counties does not completely match with the MARC or KDOT systems. Therefore, a hybrid classification network is presented in Figure 2-16. This figure is not completely consistent with all of the state or local plan maps, but it captures the practical functionality of the roads in the area in a consistent way for purposes of this analysis. As shown in the figure, US 56 serves as a rural minor arterial and Edgerton Road (north of Nelson Street), Nelson Street, Sunflower Road, 231st Street, and a few others serve as rural major collector roadways. Other roadways, such as Edgerton Road between 207th and Nelson Street and 207th from Edgerton Road to Sunflower Road, could be deemed minor collector roadways. The remaining roadways are local roadways.

Barriers in the Wellsville North area include I-35, existing development, railroad lines, parks, and streams. Again, many of these are somewhat permeable barriers, but all can present challenges to future highway connectivity.

3.0 ENVIRONMENTAL CONSEQUENCES

Direct effects to transportation were determined by evaluating the anticipated effects based on construction and opening year (2010) operation of the Proposed Action and Wellsville North Alternative. Indirect effects were evaluated for each project area by considering the following: future operations of the IMF (through 2030) and development anticipated to be induced by the IMF. For the Proposed Action, induced development consists of the Logistics Park Kansas City, as described in this section. For the Wellsville North Alternative, the exact nature of induced development is not known and therefore was not analyzed.

For the Proposed Action, the study team in collaboration with the federal, state, and local agencies decided that the Olathe Traffic Model (OTM) was reasonable for forecasting long-term (2030) traffic growth in the vicinity of the proposed Gardner IMF and land uses planned by local jurisdictions. The OTM is a computerized travel demand forecasting model developed and refined by the City of Olathe, Kansas. As a part of the demand modeling process, model input assumptions must be made regarding land use and future network changes. Review agencies, including KDOT, the City of Gardner, the City of Edgerton, Johnson County, Miami County, and MARC assisted in the determination of these assumptions. At its core, the model consists of a computerized representation of the roadway/highway network, plus an overlay of 782 Traffic Analysis Zones (TAZs) in which land-use quantities are aggregated to generate traffic volumes. For the traffic analysis, a “forecasting focus area” was defined in which land use and network adjustments could be made to refine model accuracy. Given the input of the local planning entities with regard to land use assumptions and forecasts for the OTM, this forecasting focus area was used for the indirect and cumulative effects analyses. In addition, a few large-scale projects outside of the forecasting focus area were also included in the cumulative effects analysis based on discussions with public agencies. These projects are discussed in the *Cumulative Effects Technical Report* (HDR, 2008b).

The Wellsville North development area is located southwest of the Gardner development area and outside of the boundaries of the OTM forecasting focus area as well as outside of the entire OTM planning area. As a result, quantified land use forecasts for the reasonably foreseeable future are not available.

To establish a basis against which to compare the Proposed Action and Wellsville North Alternative scenarios, No Action scenarios that anticipate planned land-use growth and associated roadway/highway improvements were created. The IMF is not included as a development in the No Action scenarios. Development and evaluation of the No Action scenarios (coupled with results of the Proposed Action and Wellsville North Alternative scenarios) allows the identification of direct project traffic impacts, if any. To evaluate direct effects from the Proposed Action and Wellsville North Alternative, the scenarios were compared for opening year (2010).

Induced development includes a proposed logistics park, Logistics Park Kansas City adjacent to BNSF's planned IMF at Gardner. The logistics park would be developed by The Allen Group – Kansas City (TAG-KC) and consist of 400,000 to 600,000 square feet of speculative freight distribution and warehouse space available for lease around the same time that BNSF's IMF opens. TAG-KC has projected that it might construct additional warehouse capacity (up to 2.86 million square feet) sometime between 2010 and 2015 depending on demand in the South Johnson County market (William Crandall Verified Statement [Crandall VS], 2008). To evaluate indirect effects associated with future operations of the IMF and development anticipated to be induced by the IMF, the horizon years for analysis were expanded to include 2015 and 2030.

Because the surrounding land use is expected to urbanize during the study time horizon, a minimum standard of LOS D was used as the threshold for acceptable traffic operations for freeway facilities and intersections. A significant impact would exist if an unacceptable LOS (i.e., E or F) was predicted to occur on a state or major route in 2010 (opening year) or in 2015 (5 years after opening). Appropriate mitigation measures are discussed in the *Mitigation Technical Report* (HDR, 2008c).

3.1 Direct Effects - Gardner

3.1.1 2010 Gardner No Action

<u>2010 Gardner No Action Forecast Volumes</u>
The 2010 Gardner No Action scenario is a near-term scenario for comparing opening day for the build scenarios. It assumes modest near-term traffic growth consistent with historical growth in the area. Based on KDOT vehicle count data, and consistent with the recently completed *I-35 Gardner Break-in-Access* (BIA) Study (HDR, 2007), a growth rate of 2.8 percent per year was assumed for intersections and a growth rate of approximately 3.2 percent per year was assumed for the I-35 mainline. These growth rates were applied to the existing (2008) volumes.

The resulting 2010 No Action ADT volumes and peak-hour turning movement volumes are illustrated in Figures 3-1 and 3-2. The volumes are rounded, reflecting the fact that they are forecasts. Peak-hour truck percentages are presented in Appendix C.

<u>2010 Gardner No Action Geometry Assumptions</u>
In 2010, the roadway network geometry was assumed to be similar to the existing network geometry, with a few notable exceptions as described below:

- *I-35/Gardner Road Interchange and Vicinity* – By 2010, KDOT is planning to improve the interchange by signalizing both ramp intersections, widening to add westbound and southbound turn lanes at the southbound ramp intersection (#21), and widening Gardner Road to four lanes from the I-35 southbound ramps north to 191st Street.

- *Moonlight Road Improvements* – The City of Gardner has plans to improve Moonlight Road near Main Street (US 56) by 2010. This includes widening Moonlight Road to four lanes and adding turn lanes at Main Street and Santa Fe Street. It also includes relocating Santa Fe Street further to the south to improve the distance between it and the railroad tracks and Main Street. The Moonlight Road/Santa Fe Street intersection is also expected to be signalized.

- *Improvements to Meet No Action Demand* – In addition to the improvements described above, several other modest improvements may be required for acceptable operations under the No Action scenario. These improvements address projected No Action scenario deficiencies and are discussed further in the operational analysis section.

Figure 3-1: 2010 Gardner No Action ADTs

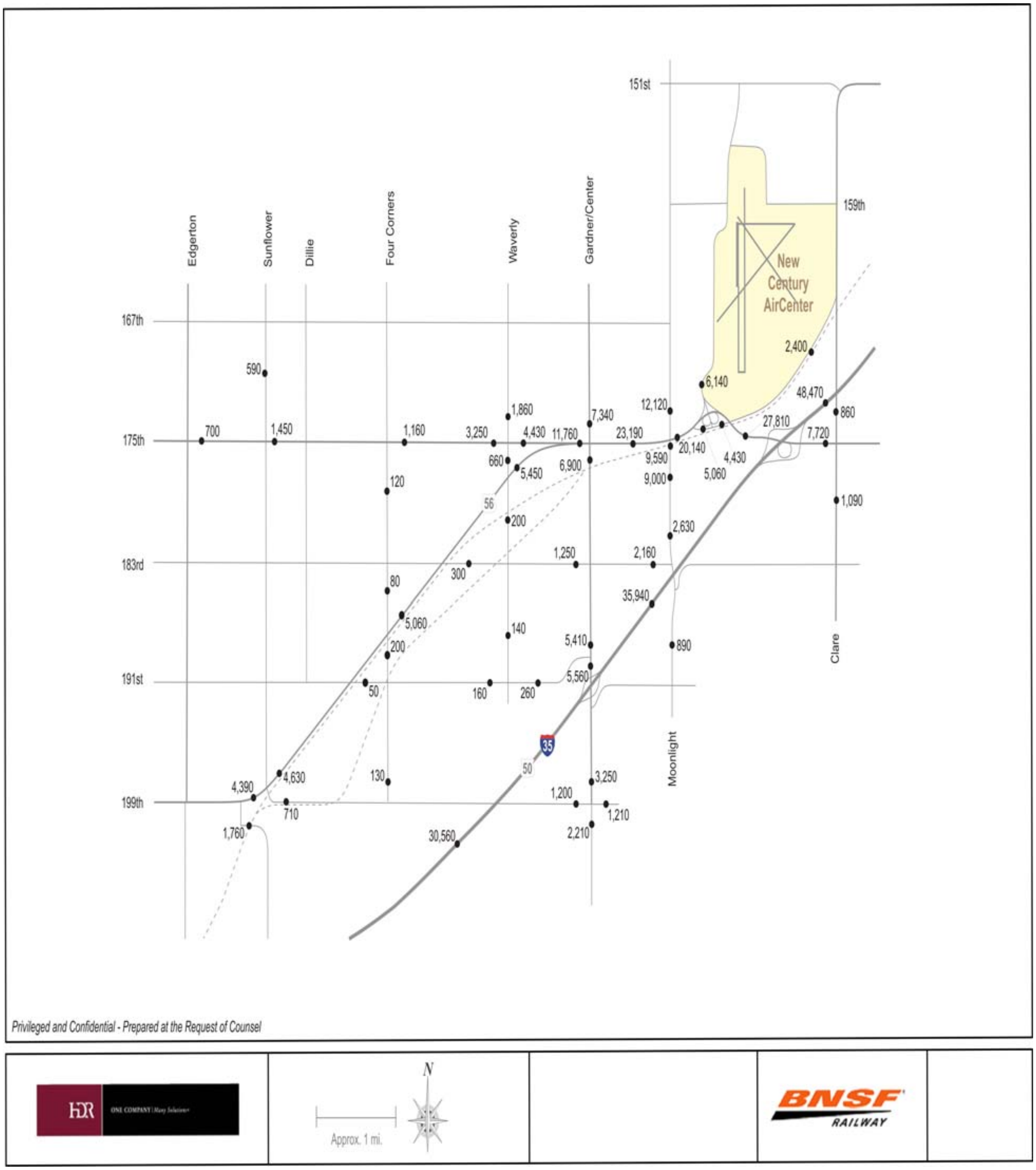
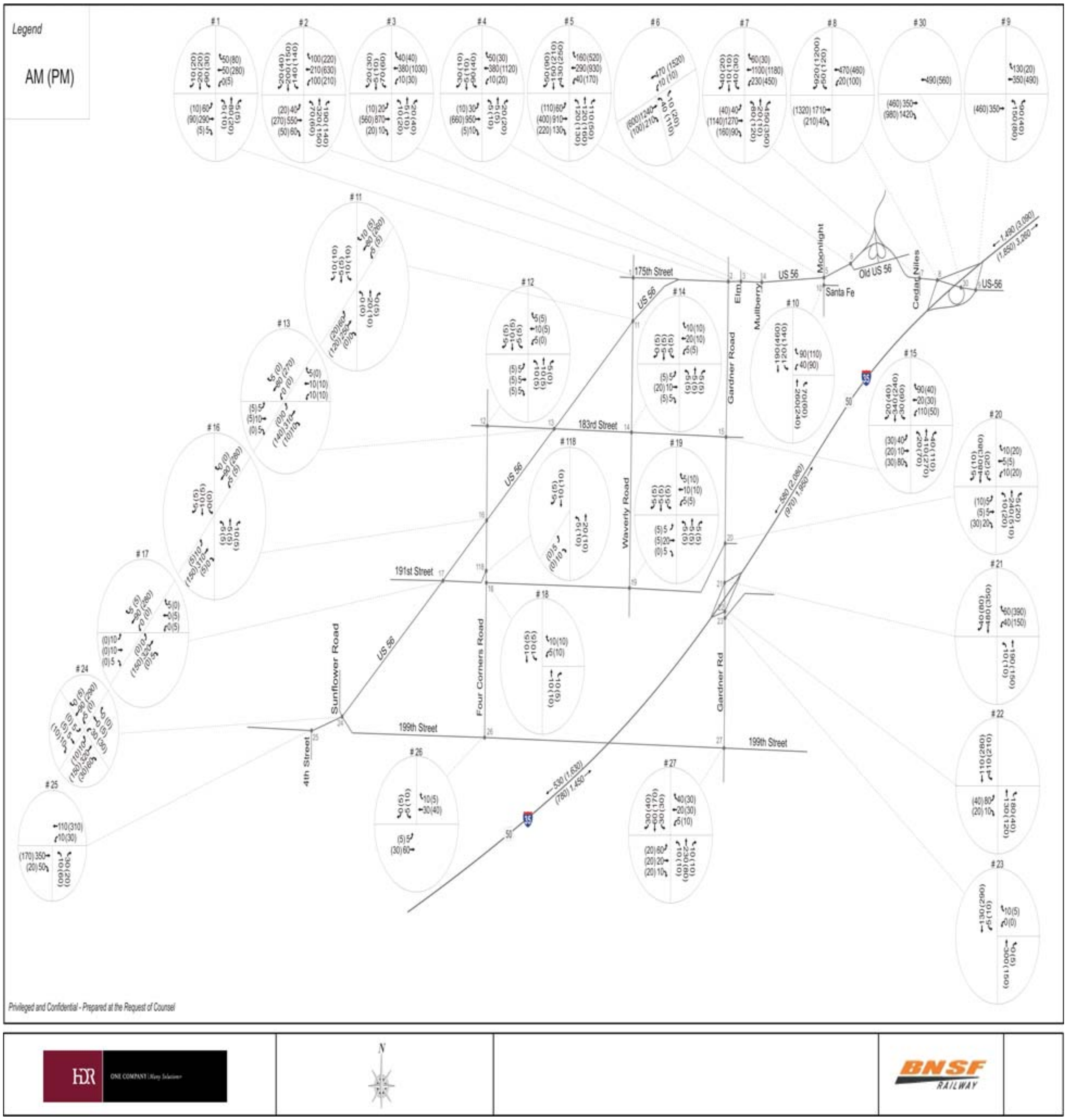


Figure 3-2: 2010 Gardner No Action Peak Hour Turning Movement Volumes



<u>2010 Gardner No Action Intersection Operational Analysis</u>

A total of 28 intersections were examined using the projected 2010 No Action traffic volumes and the assumed 2010 No Action transportation network improvements. The results of this analysis are shown in Table 3-1. (Detailed intersection calculations for all of the Gardner No Action scenarios are included in Appendix E.) In this scenario, four study intersections were forecasted to operate at LOS E or worse during one or both peak hours. These intersections include:

- *Intersection #6 (US 56/Old US 56):* This intersection is an unsignalized 3-leg intersection. The northbound movement is stop-controlled and is expected to operate at LOS F in both the a.m. and p.m. peak hours.
- *Intersection #8 (US 56/I-35 southbound ramps):* The southbound left-turn movement at this intersection is projected to operate at LOS F in the p.m. peak hour. In addition, as traffic grows the southbound right movement can also be expected to experience increased delays due to the need to merge onto US 56.
- *Intersection #9 (US 56/I-35 northbound ramps):* The northbound ramp approach to this intersection is projected to operate below the acceptable LOS threshold during both peak hours.
- *Intersection #15 (183rd Street/Gardner Road):* The westbound left-turn movement at this intersection is projected to operate at LOS E in the a.m. peak period.

Table 3-1: 2010 Gardner No Action Alternative Intersection Analysis

			No Action Analysis				**Improved No Action Analysis**			
			AM Peak Hour		**PM Peak Hour**		**AM Peak Hour**		**PM Peak Hour**	
	Location	**Traffic Control**	**Delay** (sec/veh)	**LOS**	**Delay**	**LOS**	**Delay**	**LOS**	**Delay**	**LOS**
1	175th St/ Waverly Rd	TWSC	24.3 (SB)	C	14.2 (SB)	B				
2	US 56/ Gardner Rd	Signalized	17.5	B	17.3	B				
3	US 56/ Elm St	Signalized	4.8	A	5.7	A				
4	US 56/ Mulberry St	Signalized	5.7	A	4.0	A				
5	US 56/ Moonlight Rd	Signalized	26.9	C	22.7	C				
6	US 56/ Old US 56	OWSC[1]	**61.6 (NBL)**	**F**	**127.7 (NBL)**	**F**	9.4	A	6.4	A
7	US 56/ Cedar Niles	Signalized	22.8	C	24.1	C	16.4[3]	B[3]	18.7[3]	B[3]
8	I-35 SB Ramps/ US 56	OWSC[1]	25.7 (SBL)	D[2]	**51.4 (SBL)**	**F**[2]	12.8	B	9.7	A
9	I-35 NB Ramps/ US 56	OWSC[1]	**55.9 (NB)**	**F**	**44.6 (NB)**	**E**	9.6	A	7.0	A
10	Moonlight Rd/ Santa Fe	Signalized	6.9	A	7.7	A				
11	US 56/ Waverly Rd	TWSC	14.7 (NB)	B	12.8 (SB)	B				
12	183rd St/ Four Corners Rd	AWSC	7.0	A	6.9	A				
13	183rd St/ US 56	TWSC	13.1 (EB)	B	13.3 (WB)	B				
14	183rd St/ Waverly Rd	TWSC	9.1 (SB)	A	8.9 (NB)	A				
15	183rd St/ Gardner Rd	TWSC[1]	**48.0 (WBL)**	**E**	28.5 (WBL)	D	6.9	A	5.6	A
16	US 56/ Four Corners Rd	TWSC	12.4 (NB)	B	12.6 (NB)	B				
17	191st St/ US 56	TWSC	12.7 (EB)	B	13.5 (WB)	B				
18	191st St/ Four Corners Rd	TWSC	8.6 (WB)	A	8.6 (WB)	A				
19	191st St/ Waverly Rd	TWSC	9.0 (NB)	A	8.9 (NB)	A				
20	Gardner Rd/ 188th St	Signalized	3.4	A	4.3	A				
21	I-35 SB Ramps/Gardner Rd	Signalized	6.0	A	18.3	B				
22	I-35 NB Ramps/Gardner Rd	Signalized	8.0	A	5.1	A				
23	Gardner Rd/ E 191st St	OWSC	10.1 (WB)	B	9.3 (WB)	A				
24	US 56/ Sunflower Rd	TWSC	15.2 (NW)	C	15.5 (NW)	C				
25	US 56/ E 4th St	OWSC	12.5 (NB)	B	15.4 (NB)	C				
26	199th St/ Four Corners Rd	OWSC	9.2 (SB)	A	8.9 (SB)	A				
27	199th St/ Gardner Rd	AWSC	9.3	A	8.9	A				

Notes:
TWSC – Two-way STOP control, OWSC – One-way STOP control, AWSC – All-way STOP control, LOS – Level of Service.
For one and two-way STOP-controlled intersections the delay and LOS for the worst approach is shown.
Bold indicates a LOS below the acceptable threshold.
[1] Unsignalized in 2010 No Action, Signalized in Improved 2010 No Action.
[2] The southbound right movement is assumed to be free flow.
[3] Improvement due to signal coordination

Given that these four intersections are projected to operate below the acceptable LOS threshold under the No Action scenario, it was assumed that signals would be installed at these locations by mid 2010. Signals have been discussed in recent traffic studies at the first three of these locations (# 6, 8, and 9) and all three of those locations are expected to be near the threshold for warranting signals. Signal warrant studies may be appropriate at all four locations by 2010. The No Action geometry with signals assumed at these locations is referred to as the "Improved No Action" analysis and was used as the baseline for the 2010 impact analysis. With signals at these four locations, all intersections are predicted to operate acceptably in the Improved No Action scenario. This provides a practical baseline that meets the minimum LOS standard, from which to conduct the Proposed Action impact analysis.

<u>2010 Gardner No Action Freeway and Ramp Analysis</u>

The 2010 No Action freeway analysis assumed the forecasted volumes presented in Figure 3-1 and the current mainline and ramp geometry. The resulting operational analysis (for both mainline and ramp junctions) is summarized in Table 3-2. As the table indicates, all locations are forecasted to operate at an acceptable LOS D or better during both peak hours (Detailed freeway and ramp calculations for the Gardner No Action scenarios are provided in Appendix E).

Table 3-2: 2010 Gardner No Action Freeway/Ramp Operational Analysis

Location	Lanes	AM Peak Hour Density (pc/mi/ln)	AM Peak Hour LOS	PM Peak Hour Density (pc/mi/ln)	PM Peak Hour LOS
Basic Freeway Segments					
I-35 NB					
Sunflower to Gardner	2	12.0	B	6.8	A
Gardner to US 56	2	15.9	B	8.3	A
US 56 to 151st Street	2	27.4	D	15.4	B
I-35 SB					
151st St to US 56	2	12.4	B	26.1	D
US 56 to Gardner	2	5.0	A	17.3	B
Gardner to Sunflower	2	4.6	A	13.6	B
Ramp Merge/Diverge					
I-35 NB					
Gardner Road Off	N/A	11.5	B	5.2	A
Gardner Road On	N/A	17.7	B	9.5	A
US 56 Off	N/A	16.2	B	7.1	A
US 56 EB on-loop	N/A	29.5	D	18.6	B
US 56 WB on	N/A	28.2	D	16.5	B
I-35 SB					
US 56 Off	N/A	11.9	B	27.6	C
US 56 On	N/A	5.8	A	19.0	B
Gardner Road Off	N/A	3.1	A	17.8	B
Gardner Road On	N/A	5.4	A	15.2	B

Notes: pc/mi/ln – passenger cars per mile per lane, LOS – Level of Service.
NA means not applicable

3.1.2 2010 Proposed Action

2010 Proposed Action Forecasts

The traffic generated by the Proposed Action in Gardner was estimated based on on-site employment estimates, expected shift-change patterns and opening day lift projections for the Gardner IMF in conjunction with historical data from the existing BNSF Argentine facility. Based on these sources, it was estimated that the Gardner project site would generate approximately 2,900 vpd in 2010, 273 during the a.m. peak hour and 185 during the p.m. peak hour (Table 3-3). The table separates bobtails (unloaded trucks with no chassis) because they are much lighter, and affect traffic operations much less than trucks carrying trailers or containers.

Additional information on site-trip generation is provided in Appendix A.

Table 3-3: 2010 Proposed Action Trip Generation

		AM Peak Hour			PM Peak Hour		
	Daily	in	out	total	in	out	total
Trucks	1,489	32	49	81	57	45	102
Bobtails	1,065	23	35	58	41	32	73
Non-Trucks	343	67	67	134	4	6	10
Total	2,897	122	151	273	102	83	185

Note: Bobtails are not typically measured at existing IMFs.
A conservative estimate was calculated to capture potential bobtail traffic. Actual bobtail trips are likely to be less than what has been projected as trips will be generated by lifts and container staging.

The new auto trips associated with the Proposed Action were distributed to destinations and assigned to the local roadway system in a manner consistent with the local land uses and street network. The truck traffic was distributed based on the results of a shipper survey. These truck trips were assigned based on minimizing travel times; however, it was assumed that truck traffic would be restricted from using 183rd Street as a through street. The traffic distribution assumptions (i.e., trip end locations) for both classes of traffic are provided in Appendix A.

The 2010 Proposed Action ADT and peak-hour forecasts are presented in Figures 3-3 and 3-4. The Proposed Action peak hour truck percentages are illustrated in Appendix C.

Figure 3-3: 2010 Gardner Proposed Action ADTs

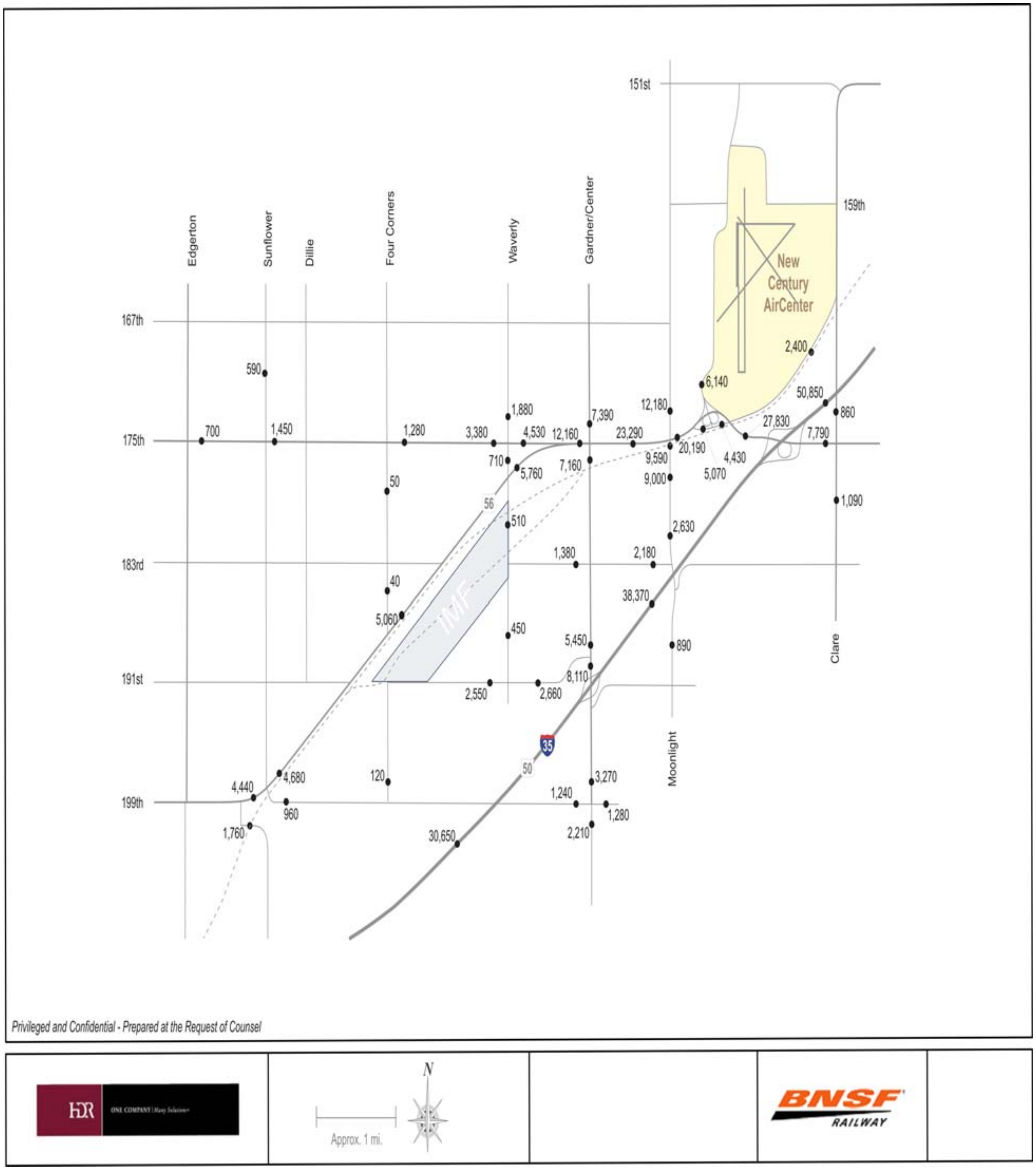
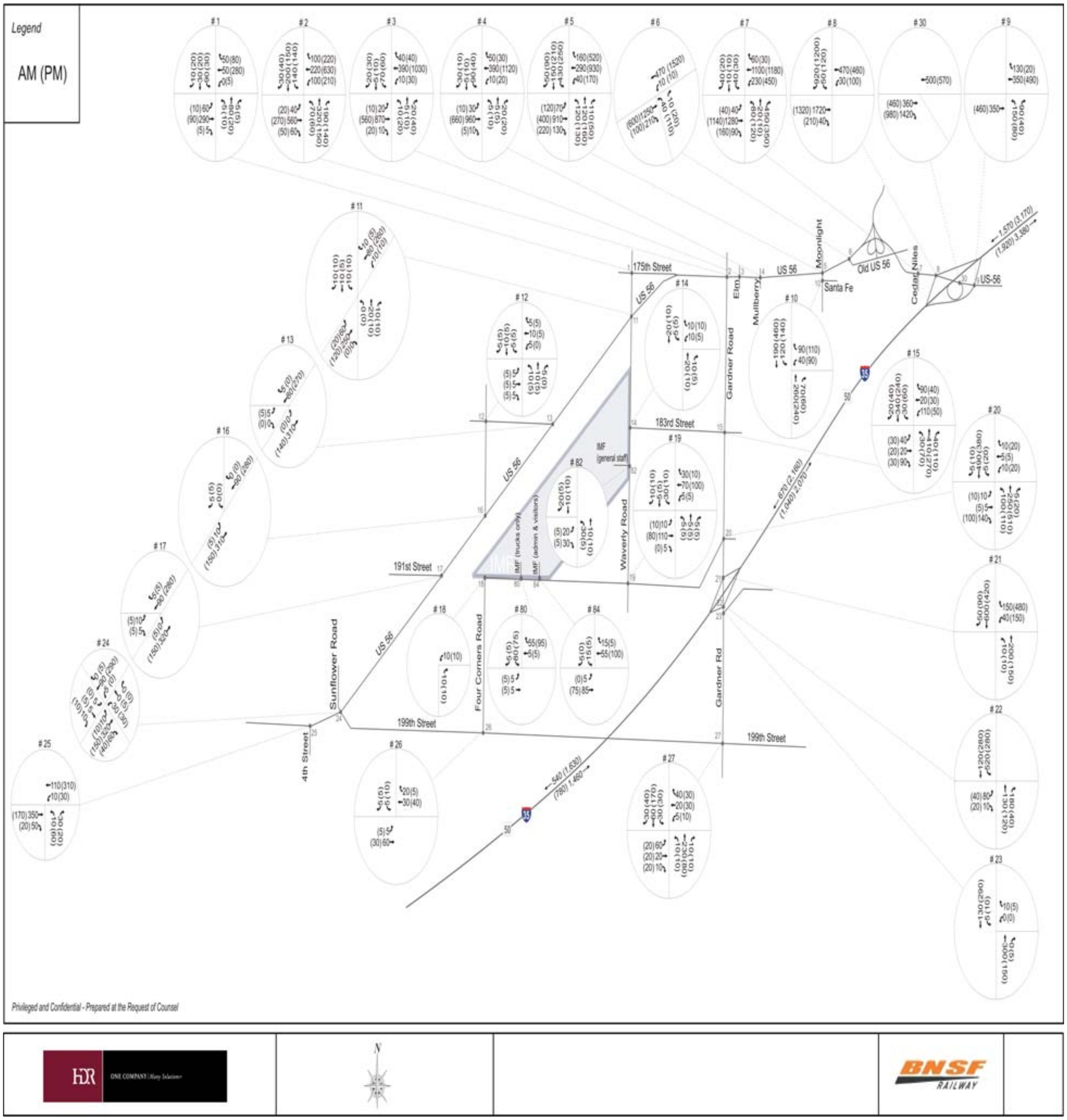


Figure 3-4: 2010 Gardner Proposed Action Turning Movement Volumes



<u>2010 Proposed Action Operations Intersection Analysis</u>

The 2010 Proposed Action operational analysis was conducted based on the 2010 Improved No Action geometry and the 2010 Proposed Action traffic volumes discussed in the previous section. The resulting levels or service for all study locations are discussed in this section.

The intersection operational analysis is summarized in Table 3-4. Intersection #1 was forecasted to drop from LOS C to D, but none of the study intersections were forecasted to operate below the LOS D threshold in the 2010 Proposed Action scenario; therefore, no significant impacts were predicted to occur (Detailed intersection analysis sheets for the Proposed Action and Future Gardner IMF scenarios are presented in Appendix E).

Table 3-4: 2010 Gardner No Action and Proposed Action Study Intersection Analysis

			No Action Analysis				**Proposed Action Analysis**			
			AM Peak hr		**PM Peak hr**		**AM Peak hr**		**PM Peak hr**	
	Location	**Traffic Control**	**Delay (sec/veh)**	**LOS**	**Delay**	**LOS**	**Delay**	**LOS**	**Delay**	**LOS**
1	175th St/ Waverly Rd	TWSC	24.4 (SB)	C	14.2 (SB)	B	25.0 (SB)	D	14.2 (SB)	B
2	US 56/ Gardner Rd	Sig	17.5	B	17.3	B	21.0	C	17.5	B
3	US 56/ Elm St	Sig	4.8	A	5.7	A	5.5	A	5.7	A
4	US 56/ Mulberry St	Sig	5.7	A	4.0	A	6.0	A	4.1	A
5	US 56/ Moonlight Rd	Sig	23.2	C	16.4	B	22.9	C	16.6	B
6	US 56/ Old US 56	Sig	9.4	A	6.4	A	10.7	B	6.3	A
7	US 56/ Cedar Niles	Sig	19.5	B	19.8	B	15.4	B	20.4	C
8	I-35 SB Ramps/ US 56	Sig	12.8	B	9.7	A	13.7	B	20.2	C
9	I-35 NB Ramps/ US 56	Sig	9.6	A	7.0	A	13.3	B	6.3	A
10	Moonlight Rd/ Santa Fe	Sig	8.0	A	7.4	A	7.9	A	7.5	A
11	US 56/ Waverly Rd	TWSC	14.7 (NB)	B	12.8 (NB)	B	13.9 (NB)	B	13.1 (SB)	B
12	183rd St/ Four Corners	AWSC	7.0	A	6.9	A	7.0	A	6.9	A
13	183rd St/ US 56	TWSC	12.8 (WB)	B	13.3 (WB)	B	11.8 (EB)	B	11.2 (EB)	B
14	183rd St/ Waverly Rd	TWSC	9.1 (SB)	A	8.9 (NB)	A	8.7 (WB)	A	8.5 (WB)	A
15	183rd St/ Gardner Rd	Sig	6.9	A	5.6	A	7.0	A	5.6	A
16	US 56/ Four Corners	TWSC	12.4 (NB)	B	12.6 (NB)	B	8.9 (SB)	A	10.3 (SB)	B
17	191st St/ US 56	TWSC	12.7 (EB)	B	13.5 (WB)	B	11.2 (EB)	B	11.5 (EB)	B
18	191st St/ Four Corners	TWSC	8.6 (WB)	A	8.6 (WB)	A				
19	191st St/ Waverly Rd	TWSC	9.0 (NB)	A	8.9 (NB)	A	10.4 (SB)	B	10.1 (SB)	B
20	Gardner Rd/ 188th St	Sig	3.6	A	4.3	A	8.1	A	6.2	A
21	I-35 SB / Gardner Rd	Sig	6.0	A	13.5	B	9.5	A	15.0	B
22	I-35 NB / Gardner Rd	Sig	9.3	A	5.2	A	21.0	C	6.8	A
23	Gardner Rd/ E 191st St	OWSC	10.1 (WB)	B	9.3 (WB)	A	10.1 (WB)	B	9.3 (WB)	A
24	US 56/ Sunflower Rd	TWSC	15.2 (NW)	C	15.5 (NW)	C	15.5 (NW)	C	15.9 (NW)	C
25	US 56/ E 4th St	OWSC	12.5 (NB)	B	15.4 (NB)	C	12.5 (NB)	B	15.4 (NB)	C
26	199th St/ Four Corners	OWSC	9.2 (SB)	A	8.9 (SB)	A	9.2 (SB)	A	9.1 (SB)	A
27	199th St/ Gardner Rd	AWSC	9.3	A	8.9	A	9.3	A	8.9	A
80	IMF (Truck Entr)						10.4 (SB)	B	10.5 (SB)	B
82	IMF (Gen Staff Entr)						9.2 (EB)	A	8.7 (EB)	A
84	IMF (Admin Entr)						9.3 (SB)	A	9.5 (SB)	A

Notes:
TWSC – Two-way STOP control, OWSC – One-way STOP control, AWSC – All-way STOP control,
LOS – Level of Service.
For one and two-way STOP controlled intersections the delay and LOS for the worst approach is shown.

<u>2010 Proposed Action Freeway and Ramp Analysis</u>

The 2010 Proposed Action freeway and ramp analysis is summarized in Table 3-5. Again, none of the freeway segments or ramp junctions was forecasted to operate below LOS D in this scenario. Therefore, the Proposed Action would result in only minor impacts to freeway and ramp operations in 2010, its first year of operations. Detailed freeway facility operational analysis sheets for the Proposed Action and Future Gardner IMF Operations scenarios are presented in Appendix E.

Table 3-5: 2010 Proposed Action Freeway/Ramp Operational Analysis

Location	Lanes	AM Peak Hour Density (pc/mi/ln)	AM Peak Hour LOS	PM Peak Hour Density (pc/mi/ln)	PM Peak Hour LOS
Basic Freeway Segments					
I-35 NB					
Sunflower to Gardner	2	12.1	B	6.8	A
Gardner to US 56	2	17.3	B	9.1	A
US 56 to 151st Street	2	29.3	D	16.2	B
I-35 SB					
151st St to US 56	2	13.1	B	27.3	D
US 56 to Gardner	2	5.9	A	18.3	C
Gardner to Sunflower	2	4.7	A	13.6	B
Ramp Merge/Diverge					
I-35 NB					
Gardner Road Off	N/A	11.6	B	5.2	A
Gardner Road On	N/A	19.5	B	9.9	A
US 56 Off	N/A	17.8	B	8.0	A
US 56 EB on-loop	N/A	30.9	D	19.5	B
US 56 WB on	N/A	29.9	D	17.6	B
I-35 SB					
US 56 Off	N/A	12.9	B	28.7	D
US 56 On	N/A	6.6	A	19.9	B
Gardner Road Off	N/A	4.2	A	19.0	B
Gardner Road On	N/A	5.6	A	15.5	B

Notes: pc/mi/ln – passenger cars per mile per lane, LOS – Level of Service.

3.2 Indirect Effects - Future Gardner IMF Operations

3.2.1 2015 Gardner No Action

<u>2015 Gardner No Action Forecast Volumes</u>

The 2015 Gardner No Action scenario is a near-term scenario for comparing No Action conditions to those from the Proposed Action five years after opening day. It assumes modest near-term traffic growth consistent with historical growth in the area. Based on KDOT count data, and consistent with the recently completed I-35 Gardner BIA Study, a growth rate of 2.8 percent per year was assumed for intersections and a growth rate of approximately 3.2 percent per year was assumed for the I-35 mainline. These growth rates were applied to the existing (2008) volumes.

The resulting 2015 No Action ADT volumes and peak-hour turning movement volumes are illustrated in Figures 3-5 and 3-6 and the peak hour truck percentages are illustrated in Appendix C. As shown in these figures, traffic is expected to continue to increase on the major study area roadways such as I-35, US 56, and Gardner Road even without construction of the Proposed Action and any indirect effects of the Proposed Action.

<u>2015 Gardner No Action Geometry Assumptions</u>

The No Action 2015 roadway network geometry was assumed to be similar to the 2010 Improved No Action geometry with the exception that it was assumed that all-way stop control would be implemented at the intersection of Waverly Road and 175th Street (Intersection #1), an improvement that was considered necessary to provide an adequate baseline LOS. KDOT is currently pursuing the development of a new interchange on I-35 between Sunflower Road and Gardner Road. It was assumed that the new interchange would not be operational until at least 2015. Therefore, to be conservative, the 2015 analysis did not include the new interchange and, as a result, presents the traffic conditions before the new interchange would open.

Figure 3-5: 2015 Gardner No Action ADTs

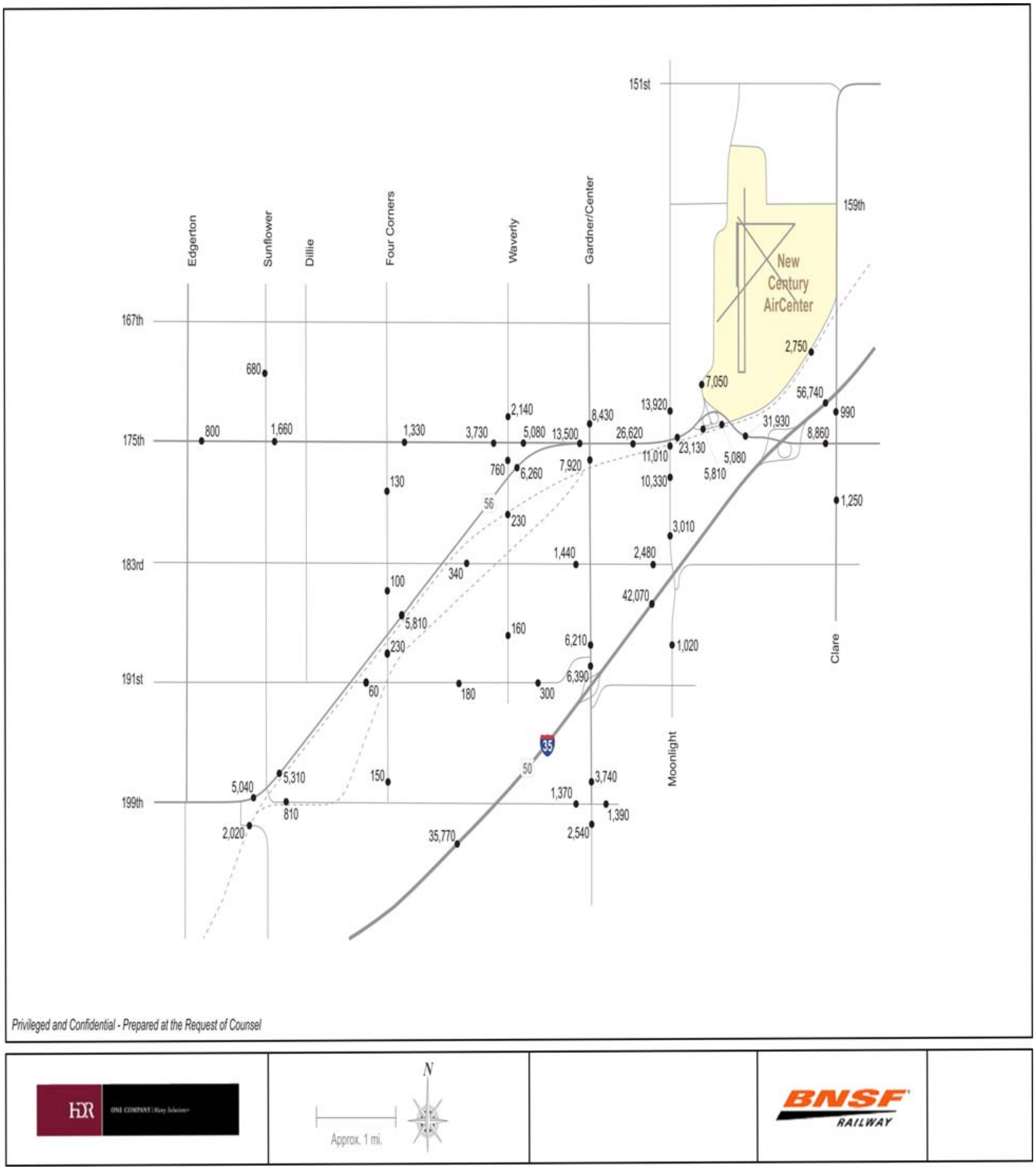
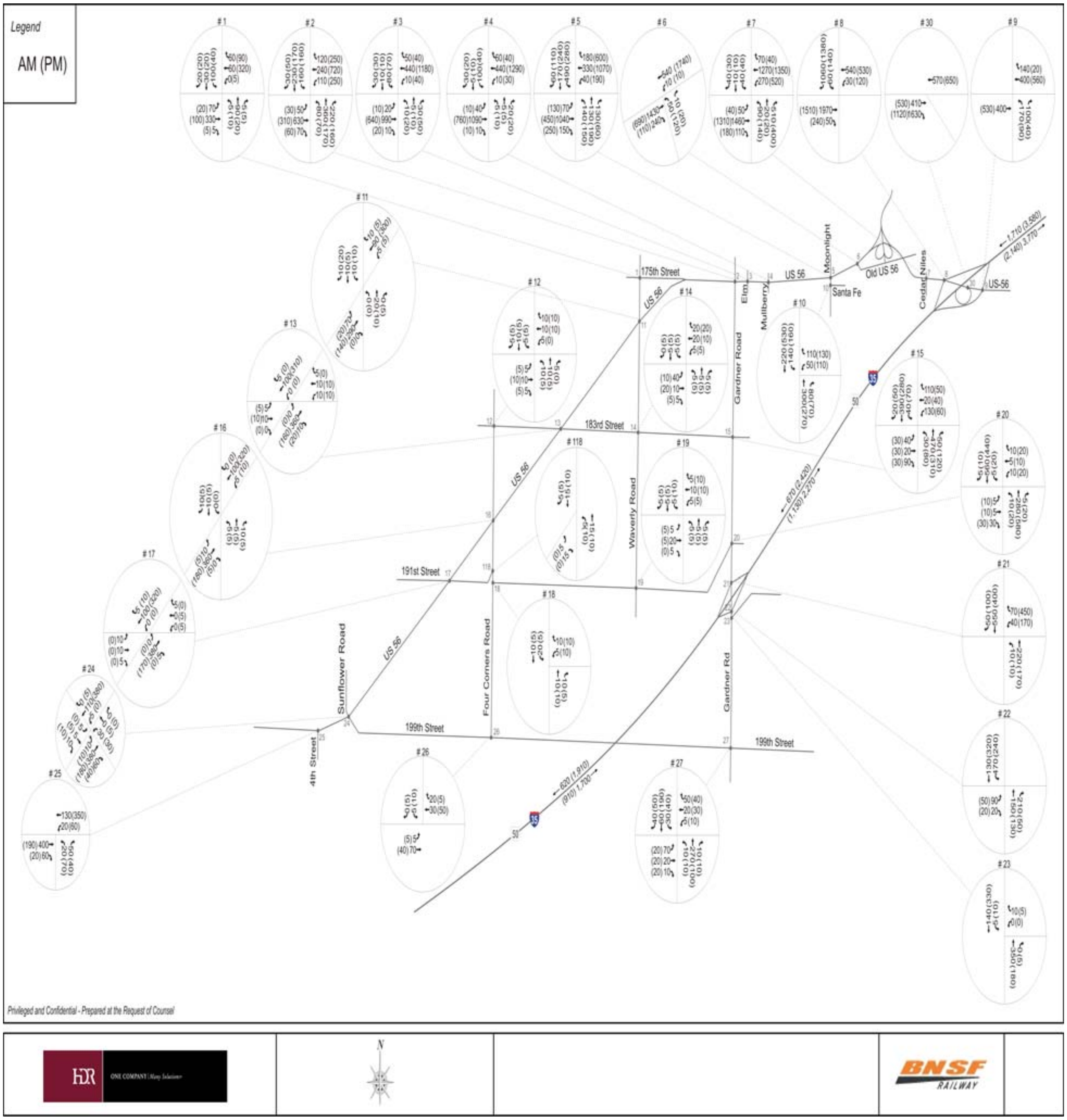


Figure 3-6: 2015 Gardner No Action Turning Movement Volumes



2015 Gardner No Action Operations Intersection Analysis

The results of the 2015 No Action operations intersection analysis are shown in Table 3-6. Given the assumed geometry described in the previous section, none of the intersections in this scenario are forecasted to operate below LOS D during the a.m. or p.m. peak periods. Therefore, only minor impacts are predicted for intersections in 2015 as a result of the No Action Alternative, assuming the previously discussed intersection improvements.

Table 3-6: 2015 Gardner No Action Study Intersection Analysis

			No Action Analysis			
			AM Peak Hour		PM Peak Hour	
	Location	Traffic Control	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
1	175th St/ Waverly Rd	AWSC	15.1	C[1]	12.3	B[1]
2	US 56/ Gardner Rd	Signalized	32.1	C	28.1	C
3	US 56/ Elm St	Signalized	6.4	A	4.2	A
4	US 56/ Mulberry St	Signalized	7.6	A	4.2	A
5	US 56/ Moonlight Rd	Signalized	25.9	C	21.1	C
6	US 56/ Old US 56	Signalized	10.8	B	6.7	A
7	US 56/ Cedar Niles	Signalized	17.4	B	22.7	C
8	I-35 SB Ramps/ US 56	Signalized	29.8	C	17.0	B
9	I-35 NB Ramps/ US 56	Signalized	11.0	B	7.6	A
10	Moonlight Rd/ Santa Fe	Signalized	8.3	A	8.4	A
11	US 56/ Waverly Rd	TWSC	16.1 (NB)	C	13.1 (SB)	B
12	183rd St/ Four Corners Rd	AWSC	7.1 (NB)	A	7.2 (NB)	A
13	183rd St/ US 56	TWSC	14.2 (EB)	B	14.5 (WB)	B
14	183rd St/ Waverly Rd	TWSC	9.2 (SB)	A	9.0 (NB)	A
15	183rd St/ Gardner Rd	Signalized	19.1	B	15.0	B
16	US 56/ Four Corners Rd	TWSC	13.3 (NB)	B	13.8 (NB)	B
17	191st St/ US 56	TWSC	13.7 (EB)	B	14.5 (WB)	B
18	191st St/ Four Corners Rd	TWSC	8.6 (WB)	A	8.6 (WB)	A
19	191st St/ Waverly Rd	TWSC	9.0 (NB)	A	8.9 (NB)	A
20	Gardner Rd/ 188th St	Signalized	3.7	A	4.0	A
21	I-35 SB Ramps/ Gardner Rd	Signalized	5.4	A	12.7	B
22	I-35 NB Ramps/ Gardner Rd	Signalized	15.4	B	6.9	A
23	Gardner Rd/ E 191st St	OWSC	10.4 (WB)	B	9.9 (WB)	A
24	US 56/ Sunflower Rd	TWSC	17.2 (NW)	C	18.9 (NW)	C
25	US 56/ E 4th St	OWSC	14.6 (NB)	B	19.0 (NB)	C
26	199th St/ Four Corners Rd	OWSC	9.3 (SB)	A	9.0 (SB)	A
27	199th St/ Gardner Rd	AWSC	9.9	A	9.4	A

Notes: TWSC – Two-way STOP control, OWSC – One-way STOP control, AWSC – All-way STOP control, LOS – Level of Service.
For one and two-way STOP controlled intersections the delay and LOS for the worst approach is shown.
[1] This LOS reflects four-way stop control. With the existing two-way stop control, the LOS would be E (38.3 sec/veh) and C (16 sec/veh) in the am and pm peaks, respectively.

2015 Gardner No Action Freeway and Ramp Analysis

The 2015 No Action freeway analysis is summarized in Table 3-7. With the additional future traffic, LOS on these facilities is forecasted to decrease from the existing primarily A/B levels, to C/D levels in a few cases. In particular, the northbound volume north of US 56 is 0.5 below the LOS E density threshold of 35 passenger cars per lane per mile. There are, however, no locations forecasted to operate at LOS E or worse in this scenario; therefore only minor impacts would occur to freeway facilities and ramps as a result from the 2015 No Action Alternative.

Table 3-7: 2015 Gardner No Action Freeway/Ramp Operational Analysis

Location	Lanes	AM Peak Hour Density (pc/mi/ln)	AM Peak Hour LOS	PM Peak Hour Density (pc/mi/ln)	PM Peak Hour LOS
Basic Freeway Segments					
I-35 NB					
Sunflower to Gardner	2	14.0	B	7.9	A
Gardner to US 56	2	18.6	C	9.7	A
US 56 to 151st Street	2	34.5	D	17.7	B
I-35 SB					
151st St to US 56	2	14.2	B	32.3	D
US 56 to Gardner	2	5.8	A	20.1	C
Gardner to Sunflower	2	5.4	A	16	B
Ramp Merge/Diverge					
I-35 NB					
Gardner Road Off	N/A	13.9	B	6.5	A
Gardner Road On	N/A	20.5	C	11.0	B
US 56 Off	N/A	19.4	B	8.7	A
US 56 EB on-loop	N/A	33.9	D	21.2	C
US 56 WB on	N/A	32.8	D	19.2	B
I-35 SB					
US 56 Off	N/A	14.1	B	32.5	D
US 56 On	N/A	6.6	A	22.0	C
Gardner Road Off	N/A	4.0	A	21.2	C
Gardner Road On	N/A	6.3	A	17.7	B

Notes: pc/mi/ln – passenger cars per mile per lane, LOS – Level of Service.

3.2.2 2015 Gardner IMF Operations

<u>2015 Gardner IMF Operations Forecasts</u>

The 2015 trip generation and distribution process for the Gardner IMF was identical to that used for the 2010 scenario, only with a higher annual lift count (495,000 in 2015 as compared to 415,000 in 2010). This higher lift count resulted in more trips - a total of nearly 3,500 vpd, including 335 during the a.m. peak hour and 222 during the p.m. peak hour. Table 3-8 summarizes the 2015 trip generation assumptions. Additional information on the daily and peak hour trip generation is provided in Appendix A.

Table 3-8: 2015 Gardner IMF Operations Trip Generation

		AM Peak Hour			PM Peak Hour		
	Daily	in	out	total	in	out	total
Trucks	1,776	39	58	97	68	54	122
Bobtails	1,270	28	42	70	49	38	87
Non-Trucks	430	84	84	168	5	8	13
Total	3,476	151	184	335	122	100	222

Note: Bobtails are not typically measured at existing IMFs. A conservative estimate was calculated to capture potential bobtail traffic. Actual bobtail trips are likely to be less than what has been projected as trips will be generated by lifts and container staging.

The 2015 Gardner IMF Operations ADT and peak-hour forecasts are shown in Figures 3-7 and 3-8. The peak hour truck percentages are illustrated in Appendix C. The operational analysis for this scenario was conducted based on the 2015 Improved No Action geometry and the 2015 Gardner IMF Operations traffic volumes. The resulting levels or service for all study locations are discussed in the following sections.

Figure 3-7: 2015 Gardner IMF Operations ADTs

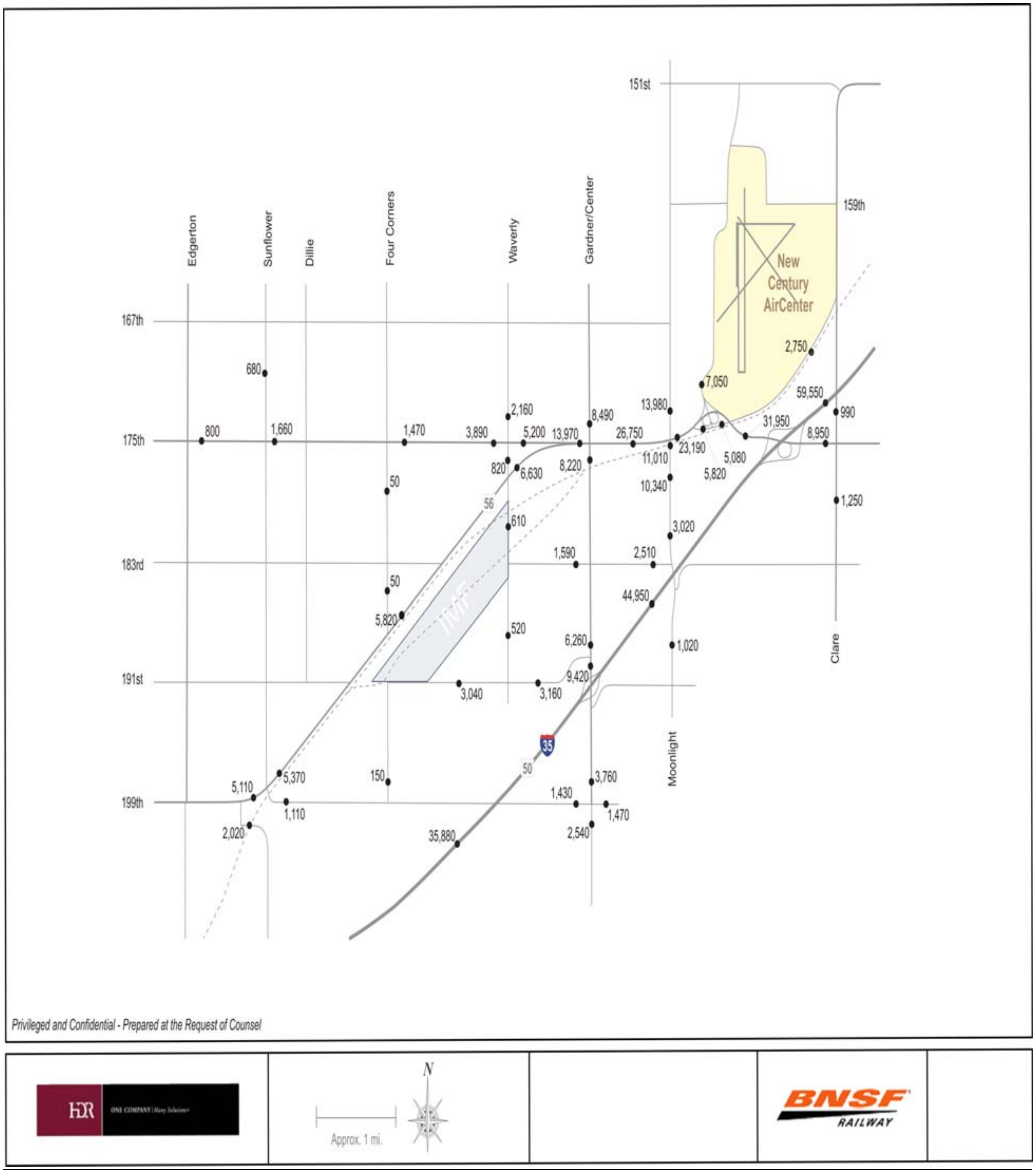
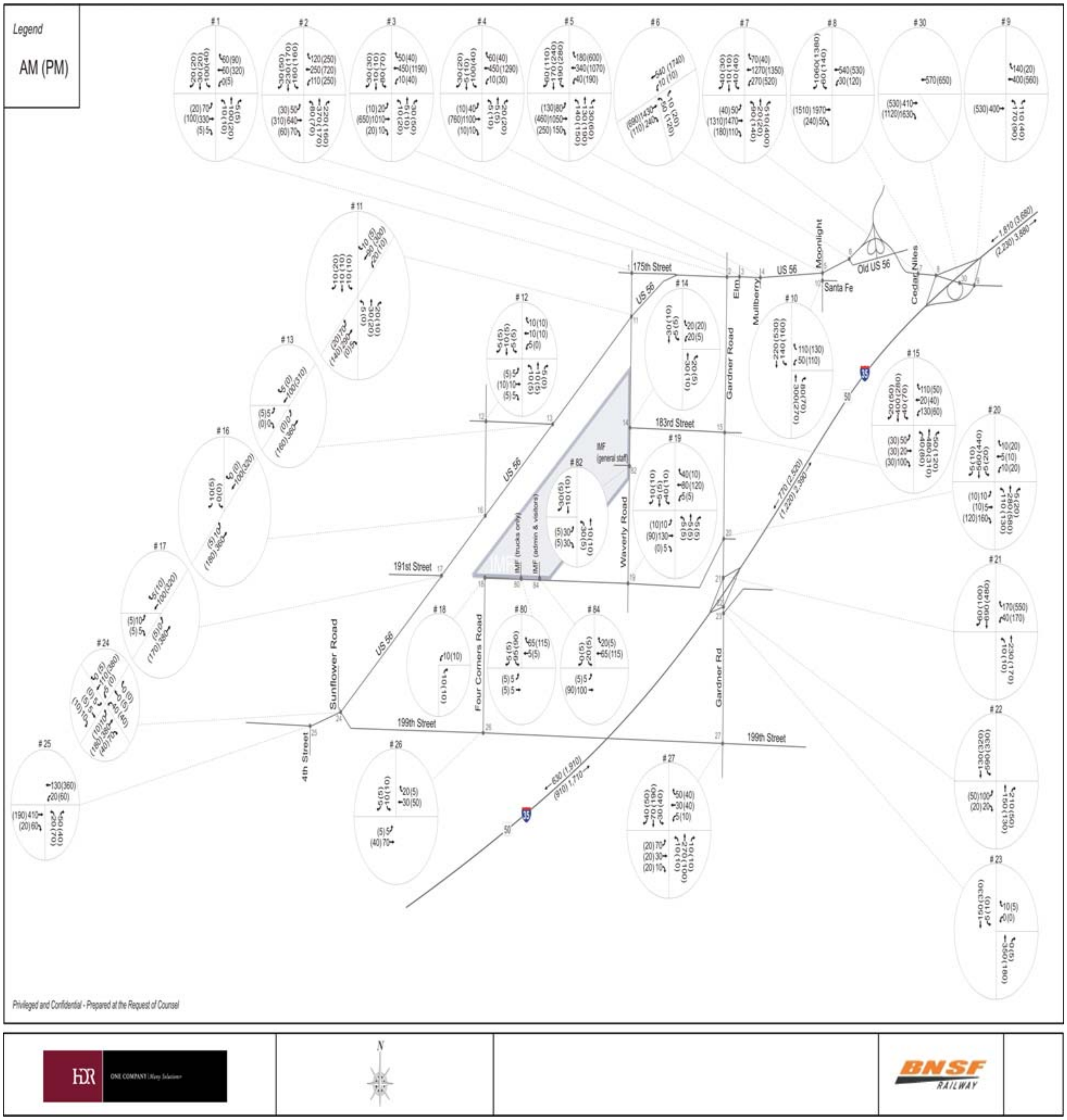


Figure 3-8: 2015 Future Gardner IMF Operations Turning Movement Volumes



2015 Gardner IMF Operations Intersection Analysis

The intersection operational analysis is summarized in Table 3-9. One intersection (Intersection #22, I-35 Northbound Ramps/Gardner Road) was forecasted to drop to LOS D, but none of the study intersections would operate below the LOS D threshold in the 2015 Gardner IMF Operations scenario. Therefore, only minor impacts are predicted in 2015 to local intersections as a result of the Proposed Action.

Table 3-9: 2015 Gardner No Action and Future Gardner IMF Operations Study Intersection Analysis

			No Action Analysis				Proposed Action Analysis			
			AM Peak Hr		PM Peak Hr		AM Peak Hr		PM Peak Hr	
	Location	Traffic Control	Delay (sec/veh)	LOS	Delay	LOS	Delay	LOS	Delay	LOS
1	175th St/ Waverly Rd	AWSC	15.1	C	12.3	B	15.5	C	12.4	B
2	US 56/ Gardner Rd	Sig	24.9	C	27.1	C	26.1	C	27.8	C
3	US 56/ Elm St	Sig	4.5	A	3.8	A	4.7	A	3.9	A
4	US 56/ Mulberry St	Sig	5.4	A	3.8	A	5.7	A	3.7	A
5	US 56/ Moonlight Rd	Sig	27.6	C	24.8	C	28.4	C	22.7	C
6	US 56/ Old US 56	Sig	9.9	A	9.2	A	11.1	B	9.5	A
7	US 56/ Cedar Niles	Sig	19	B	21.5	C	15.7	B	21.4	C
8	I-35 SB Ramps/ US 56	Sig	13.5	B	16.7	B	16.4	B	34.8	C
9	I-35 NB Ramps/ US 56	Sig	12.2	B	7	A	14.7	B	8.3	A
10	Moonlight Rd/ Santa Fe	Sig	8.4	A	8.6	A	8.2	A	8.1	A
11	US 56/ Waverly Rd	TWSC	16.1 (NB)	C	13.0 (SB)	B	16.2 (NB)	C	13.8 (SB)	B
12	183rd St/ Four Corners	AWSC	7.0	A	6.9	A	7.0	A	6.9	A
13	183rd St/ US 56	TWSC[1]	14.2 (EB)	B	14.5 (WB)	B	12.7 (EB)	B	12.8 (EB)	B
14	183rd St/ Waverly Rd	TWSC[1]	9.2 (SB)	A	9.0 (NB)	A	8.9 (WB)	A	8.5 (WB)	A
15	183rd St/ Gardner Rd	Sig	19.1	B	15	B	13.2	B	8.8	A
16	US 56/ Four Corners	TWSC[1]	13.3 (NB)	B	13.8 (NB)	B	9.0 (SB)	A	10.7 (SB)	B
17	191st St/ US 56	TWSC[1]	13.7 (EB)	B	14.5 (WB)	B	11.9 (EB)	B	12.2 (EB)	B
18	191st St/ Four Corners	TWSC	8.6 (WB)	A	8.6 (WB)	A	--	--	--	--
19	191st St/ Waverly Rd	TWSC	9.0 (NB)	A	8.9 (NB)	A	10.8 (SB)	B	10.3 (SB)	B
20	Gardner Rd/ 188th St	Sig	3.7	A	4	A	11.3	B	5.7	A
21	I-35 SB / Gardner Rd	Sig	5.4	A	12.7	B	12	B	13.6	B
22	I-35 NB / Gardner Rd	Sig	15.4	B	6.9	A	53.5	D	9.3	A
23	Gardner Rd/ E 191st St	OWSC	10.4 (WB)	B	9.5 (WB)	A	10.4 (WB)	B	9.5 (WB)	A
24	US 56/ Sunflower Rd	TWSC	17.2 (NW)	C	18.9 (NW)	C	18.2 (NW)	C	20.0 (NW)	C
25	US 56/ E 4th St	OWSC	14.6 (NB)	B	19.0 (NB)	C	14.7 (NB)	B	19.3 (NB)	C
26	199th St/ Four Corners	OWSC	9.3 (SB)	A	9.0 (SB)	A	9.4 (SB)	A	9.3 (SB)	A
27	199th St/ Gardner Rd	AWSC	9.9	A	9.4	A	10.1	B	9.5	A
80	IMF (Truck Entr)	OWSC	--	--	--	--	10.6 (SB)	B	10.8 (SB)	B
82	IMF (Gen Staff Entr)	OWSC	--	--	--	--	9.2 (EB)	A	8.7 (EB)	A
84	IMF (Admin Entr)	OWSC	--	--	--	--	9.7 (SB)	A	9.4 (SB)	A

Notes: TWSC – Two-way STOP control, OWSC – One-way STOP control, AWSC – All-way STOP control, LOS – Level of Service.
For one and two-way STOP-controlled intersections the delay and LOS for the worst approach is shown.
[1] In the Proposed Action scenario these intersections become OWSC due to road closures.

Table 3-10: 2015 Gardner IMF Operations Freeway/Ramp Operational Analysis

Location	Lanes	AM Peak Hour Density (pc/mi/ln)	AM Peak Hour LOS	PM Peak Hour Density (pc/mi/ln)	PM Peak Hour LOS
Basic Freeway Segments					
I-35 NB					
Sunflower to Gardner	2	14.1	B	7.9	A
Gardner to US 56	2	19.9	C	10.7	A
US 56 to 151st Street	2	**37.3**	**E**	18.8	C
I-35 SB					
151st St to US 56	2	15.2	B	34.5	D
US 56 to Gardner	2	6.8	A	21.4	C
Gardner to Sunflower	2	5.5	A	16	B
Ramp Merge/Diverge					
I-35 NB					
Gardner Road Off	N/A	14	B	6.6	A
Gardner Road On	N/A	22.6	C	11.5	B
US 56 Off	N/A	21	C	9.9	A
US 56 EB on-loop	N/A	**35.2**	**E**	22.3	C
US 56 WB on	N/A	34.4	D	20.5	C
I-35 SB					
US 56 Off	N/A	15.3	B	33.8	D
US 56 On	N/A	7.6	A	23.1	C
Gardner Road Off	N/A	5.3	A	22.7	C
Gardner Road On	N/A	6.5	A	18.1	B

Notes: pc/mi/ln – passenger cars per mile per lane, LOS – Level of Service.
Bold indicates a LOS below the acceptable threshold.

2015 Gardner IMF Operations Freeway and Ramp Analysis

The 2015 Gardner IMF Operations freeway and ramp analysis is summarized in Table 3-10. One freeway segment that was forecasted to operate at LOS D (near the LOS E boundary) under No Action conditions is shown to just cross the LOS E threshold under this scenario:

- *I-35 Northbound, US 56 to 151st Street:* This segment is projected to operate at LOS E during the a.m. peak hour. Widening I-35 to carry three lanes in each direction is included in MARC's Long-Range Transportation Plan (LRTP) for construction sometime between 2011 and 2020, and would improve the LOS to acceptable levels.

A related LOS issue also is forecasted to occur on the US 56 eastbound on-loop to US 56: the LOS drops from D (near the E threshold) to E (just over the threshold). Again, the programmed improvements in MARC's LRTP should improve this LOS to acceptable levels.

In summary, although the analysis identified two LOS issues, both would be anticipated to be addressed by planned improvements in the fairly near term. If for some reason, the planned improvements to I-35 do not follow what is currently outlined in the LRTP, the 2015 traffic volumes would be near the LOS D/E threshold. Only minimal traffic diversion to the local and regional arterial street system in 2015 would be expected.

3.2.3 2030 Gardner No Action

2030 Gardner No Action Forecast Volumes

The 2030 Gardner No Action scenario is a long-term scenario for comparing No Action and Proposed Action plus the associated indirect effects conditions based on a 20-year time horizon from opening year. The forecasts developed for this scenario were developed using the OTM, adjusted as necessary to refine network and land use assumptions. This model takes into account both long-term land use projections as well as future roadway improvements that are expected to be in place by the horizon year of 2030. The assumptions used in this analysis were developed through a consensus process with appropriate federal, state, and local agencies. The assumptions and the forecasting process are presented in detail in Appendix A. It was assumed a new I-35 interchange would be available by 2030 between Gardner Road and Sunflower Road. For purposes of this analysis, the interchange was assumed to be located near 199th Street and Waverly Road and Waverly Road would be extended south to 199th Street. A break-in-access study has been prepared and KDOT is currently evaluating possible new interchange locations and preparing NEPA documentation.

The resulting 2030 No Action ADT volumes and peak-hour turning movement volumes are illustrated in Figures 3-9 and 3-10. Peak hour truck percentages are illustrated in Appendix C. As these are long-term forecasts, taking into account both new land uses and new highway improvements, the changes from 2015 to 2030 are considerable in some areas. For example, traffic volumes are projected to increase appreciably on US 56 (in the eastern portion of the study area) and I-35. Volumes at both the I-35/US 56 and I-35/Gardner Road interchanges also forecasted to increase appreciably. Due to the assumption of a new interchange at Waverly, traffic volumes on US 56 between Waverly Road and Sunflower Road are actually forecasted to decrease, while traffic volumes on Waverly Road and 199th Street are projected to increase. Some specific highlights in comparing existing and 2030 ADTs:

- Daily volumes on I-35 are forecasted to roughly double, from a current 28,000-46,000 vpd (vpd) range to a 56,000-96,000 range.
- Daily volumes on US 56 between Gardner Road/Center Street and I-35 are forecasted to increase from an existing 19,000-26,000 to a 33,000-43,000 vpd range. East of I-35, volumes are forecasted to jump from 7,300 to 33,000 vpd.
- Daily volumes on Gardner Road/Center Street are expected to increase from a current 5,000-7,000 vpd range to a 21, 000-28,000 range.
- 199th Street is expected to increase from current volumes on the order of 1,000 vpd to volumes ranging from 8,000 to 16,000 vpd.

Similar increases were forecasted during the a.m. and p.m. peak hours.

<u>2030 Gardner No Action Geometry Assumptions</u>
The No Action 2030 roadway network geometry includes a number of assumed enhancements to attempt to provide sufficient capacity for the projected 2030 No Action traffic. Figure 3-11 illustrates the assumed geometry and control for the study intersections.

The model includes many other assumptions regarding future improvements for the entire area covered by the model. These future improvements were assumed to be consistent with agency plans and were not changed as part of this project.

Figure 3-9: 2030 Gardner No Action ADTs

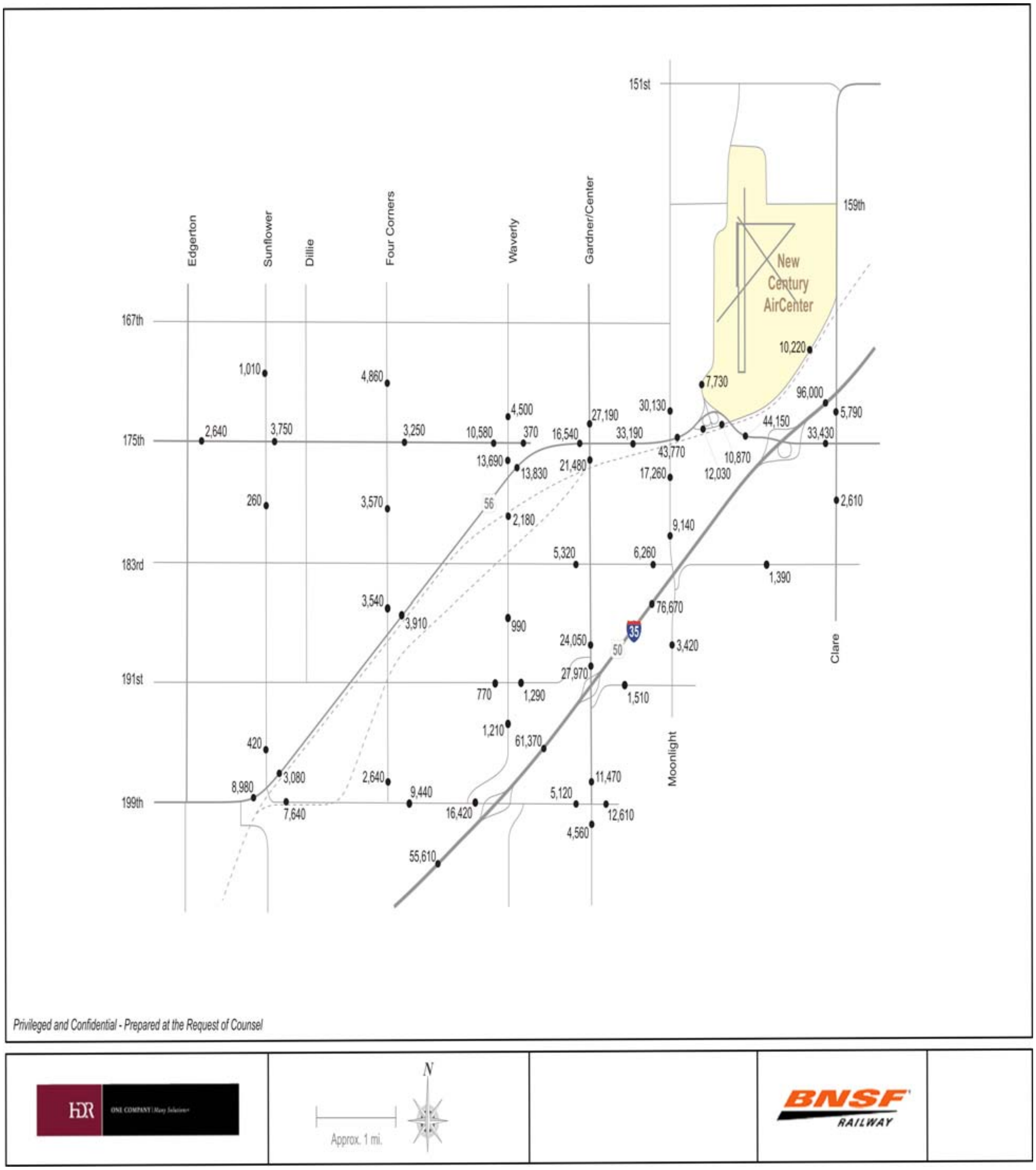


Figure 3-10: 2030 Gardner No Action Turning Movement Volumes

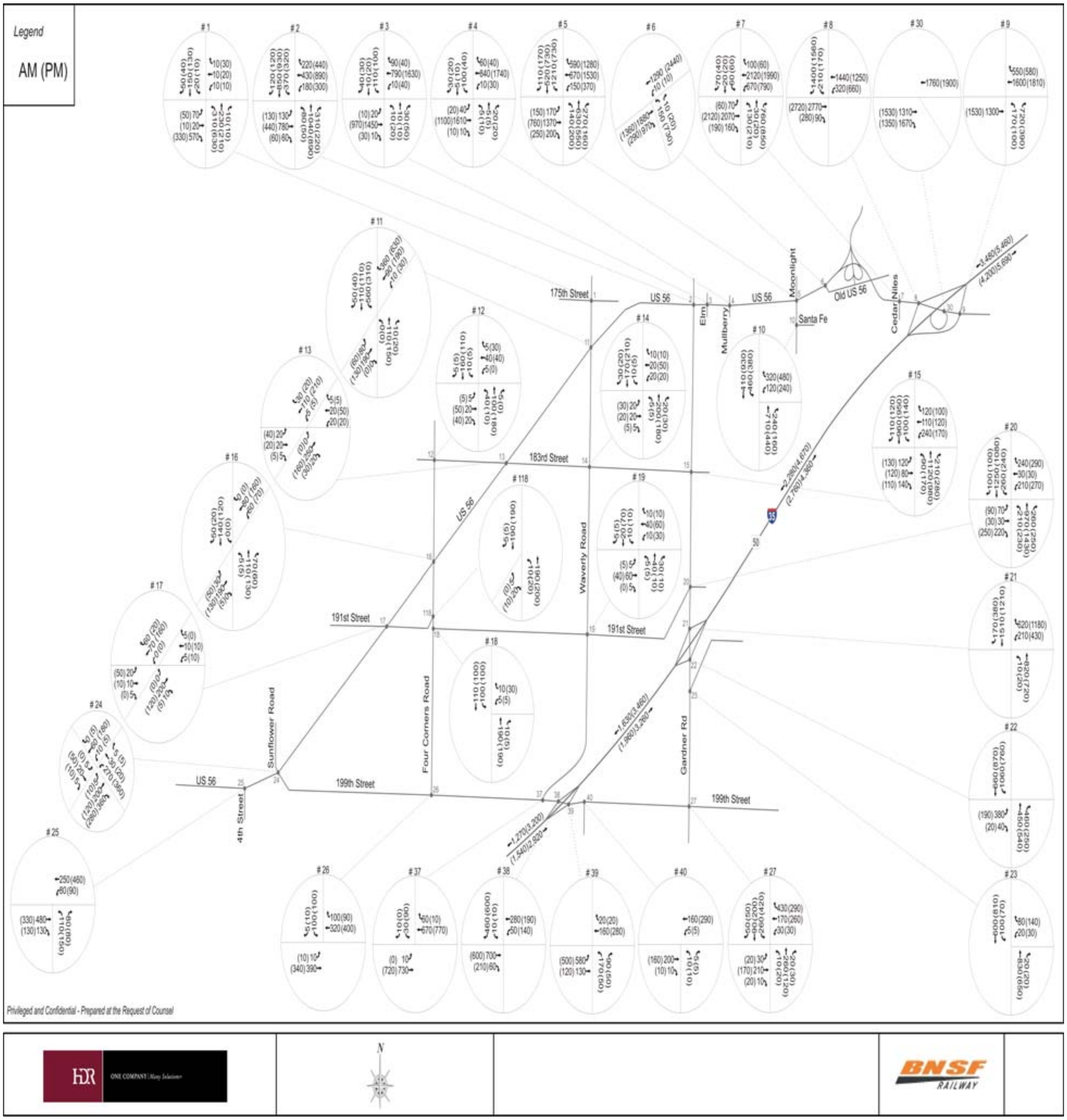
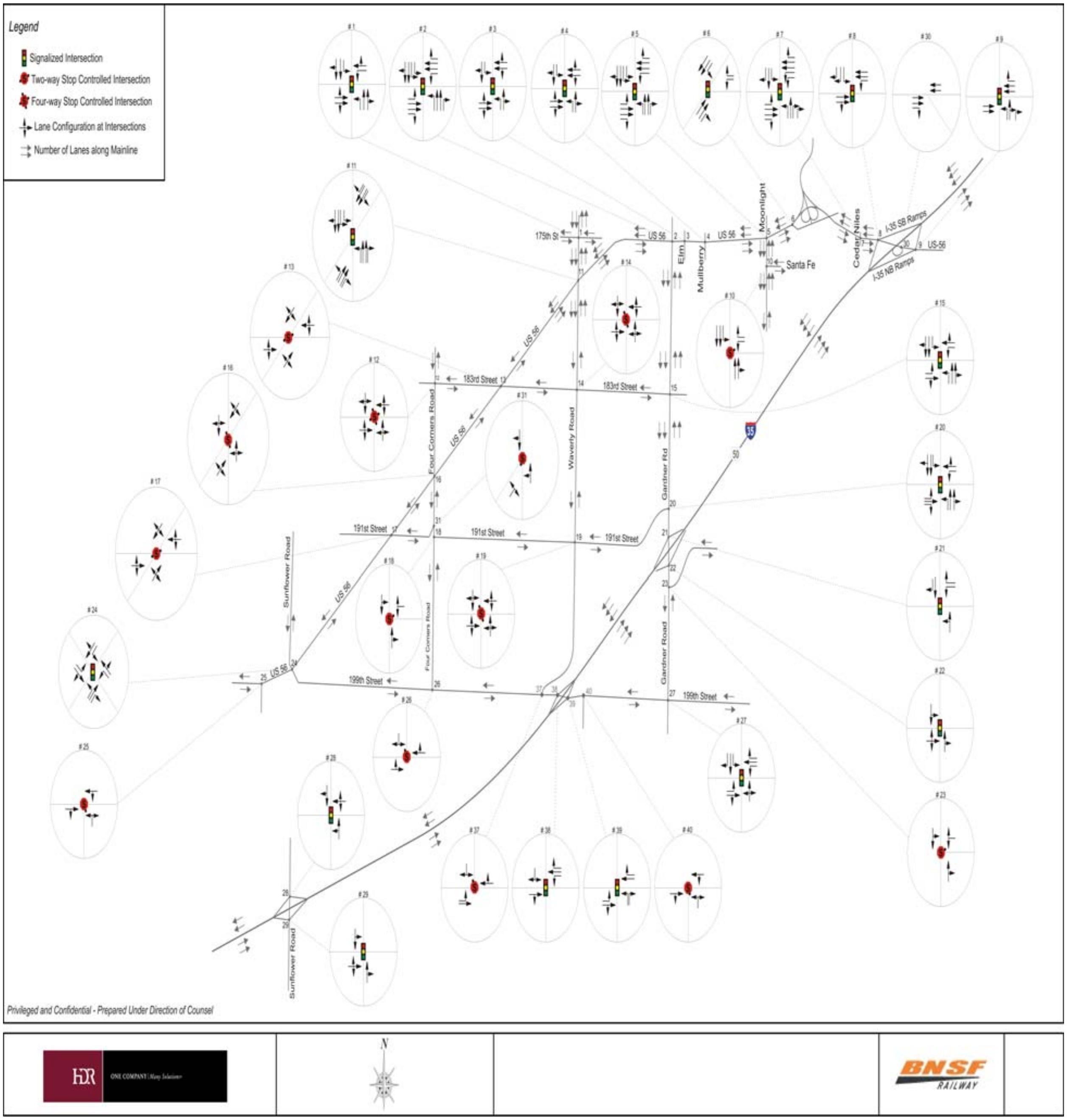


Figure 3-11: 2030 Gardner No Action Lane Configuration and Traffic Control



2030 Gardner No Action Intersection Analysis

The results of the 2030 No Action intersection analysis are shown in Table 3-11. As the table indicates, several study intersections are forecasted to operate at LOS E or worse under this scenario during one or both peak hours.

Table 3-11: 2030 Gardner No Action and Improved No Action Study Intersection Analysis

			No Action				Improved No Action			
			AM Peak hr		PM Peak hr		AM Peak hr		PM Peak hr	
	Location	Traffic Control	Delay (sec/veh)	LOS	Delay	LOS	Delay	LOS	Delay	LOS
1	175th St/ Waverly Rd	Sig	19.0	B	15.4	B	19.0	B	15.4	B
2	US 56/ Gardner Rd	Sig	29.2	C	27.5	C	29.1	C	27.2	C
3	US 56/ Elm St	Sig	6.7	A	8.2	A	6.7	A	8.2	A
4	US 56/ Mulberry St	Sig	5.6	A	4.4	A	5.6	A	4.4	A
5	US 56/ Moonlight Rd	Sig	**105.1**	**F**	**111**	**F**	**105.9**	**F**	**111.4**	**F**
6	US 56/ Old US 56	Sig	13.9	B	**91.7**	**F**	13.7	B	24.9	C
7	US 56/ Cedar Niles	Sig	36.8	D	**60**	**E**	36.7	D	**60.4**	**E**
8	I-35 SB Ramps/ US 56	Sig	**119.7**	**F**	**184.6**	**F**	**119.3**	**F**	**184.3**	**F**
9	I-35 NB Ramps/ US 56	Sig	20.8	C	12.4	B	21	C	12.5	B
10	Moonlight Rd/ Santa Fe	Sig	22.2	C	20.9	C	22.1	C	19.3	B
11	US 56/ Waverly Rd	Sig	25.8	C	34.1	C	25.8	C	34.0	C
12	183rd St/ Four Corners	AWSC	8.4	A	8.6	A	8.4	A	8.6	A
13	183rd St/ US 56	TWSC	12.4 (WB)	B	13.4 (EB)	B	12.4 (WB)	B	13.4 (EB)	B
14	183rd St/ Waverly Rd	TWSC	12.0 (NB)	B	13.0 (SB)	B	12.0 (NB)	B	13.0 (SB)	B
15	183rd St/ Gardner Rd	Sig	27.8	C	25.5	C	24.6	C	18.9	B
16	US 56/ Four Corners	TWSC	15.8 (SB)	C	18.2 (NB)	C	15.8 (SB)	C	18.2 (NB)	C
17	191st St/ US 56	TWSC	11.0 (EB)	B	11.4 (EB)	B	11.0 (EB)	B	11.4 (EB)	B
18	191st St/ Four Corners	OWSC	10.3 (WB)	B	10.0 (WB)	B	10.3 (WB)	B	10.0 (WB)	B
19	191st St/ Waverly Rd	TWSC	10.0 (SB)	A	10.8 (SB)	B	10.0 (SB)	A	10.8 (SB)	B
20	Gardner Rd/ 188th St	Sig	24.4	C	36.1	D	24.3	C	37.6	D
21	I-35 SB / Gardner Rd	Sig	**118.9**	**F**	**247.5**	**F**	13.1	B	24.3	C
22	I-35 NB / Gardner Rd	Sig	**483.4**	**F**	**373.5**	**F**	39.9	D	21.1	C
23	Gardner Rd/ E 191st St	Sig[1]	**93.7 (WB)**	**F**	**191.8 (WB)**	**F**	6.3	A	9.5	A
24	US 56/ Sunflower Rd	Sig	18.6	B	20.8	C	19.0	B	19.3	B
25	US 56/ E 4th St	Sig	11.0	B	11.9	B	10.9	B	11.7	B
26	199th St/ Four Corners	OWSC	20.0 (SB)	C	20.8 (SB)	C	20.0 (SB)	C	20.8 (SB)	C
27	199th St/ Gardner Rd	Sig	26.0	C	21.6	C	27.0	C	21.7	C
37	199th St/Waverly Rd	OWSC	16.9 (SB)	C	21.1 (SB)	C	16.9 (SB)	C	21.1 (SB)	C
38	199th St/I-35 SB	Sig	14.6	B	20.3	C	16.5	B	21.1	C
39	199th St/I-35 NB	Sig	13.0	B	8.3	A	14.0	B	7.7	A
40	199th St/Waverly Rd	OWSC	10.6 (NB)	B	11.1(NB)	B	10.6 (NB)	B	11.1 (NB)	B

Notes: TWSC – Two-way STOP control, OWSC – One-way STOP control, AWSC – All-way STOP control, LOS – Level of Service.
Bold indicates a LOS below the acceptable threshold.
For one and two-way STOP-controlled intersections the delay and LOS for the worst approach is shown.
[1] Unimproved condition is unsignalized.

- *Intersections #5 through #8 (US 56 from Moonlight Road to I-35 southbound ramps):* All four of these study intersections are projected to operate at LOS E or F during the a.m. and p.m. peak hours. The primary factor affecting operations at these intersections is heavy forecasted traffic on US 56 (peaking in the eastbound direction in the morning and the westbound direction during the evening). The basic conclusion that can be drawn from these results is that US 56 would require three through lanes in each direction from I-35 to at least Moonlight Road under this scenario (No Action Alternative). Additionally, it may be that Moonlight Road in particular, may need future attention for vehicles approaching US 56 from the south, as queuing in the vicinity of the railroad tracks will likely continue to increase.

- *Intersections #21 and #22 (I-35/Gardner Road interchange):* Both of the ramp intersections are forecasted to operate at LOS F during both peak hours, with volumes far exceeding the improved capacities assumed for the No Action Alternative in 2030. These results suggest that the interchange would need to be reconstructed to provide a wider bridge (with perhaps a 7-lane cross-section: two through lanes in each direction, two southbound left-turn lanes, and one northbound left-turn lane), and widened off-ramps (likely four lanes on the southbound off-ramp approach and three lanes on the northbound off-ramp approach). Further, the southbound off-ramp would likely need to be a two-lane exit from I-35.

- *Intersection #23 (Gardner Road/191st Street south):* The stop-controlled westbound (191st Street) approach to this unsignalized intersection is forecasted to operate at LOS F during both peak hours. Forecasted commercial, residential, and industrial growth on Gardner Road south of the intersection would result in heavy north-south through volumes, delaying side-street motorists. This level of traffic indicates that Gardner Road south of the I-35 interchange might eventually need to be widened to four lanes to serve future development. At this particular intersection, signalization or turn prohibitions might eventually be necessary to improve side-street operations.

Overall, the 2030 No Action traffic operational analysis demonstrates that many key intersections in the study area are expected to reach or exceed capacity even with the planned transportation network improvements assumed in this analysis. These future operational deficiencies are predicted to occur regardless of the Proposed Action and any indirect effects of the Proposed Action.

In evaluating the No Action scenario, it became evident that several of the intersections would likely be improved by 2030 to address LOS issues associated with the projected traffic growth in the area. Therefore, an Improved No Action scenario was developed that included improvements that would be anticipated to occur in this time frame, but that have not been explicitly identified by state or local agencies. The effects of these potential improvements are summarized in the right half of Table 3-11. Each is discussed as follows:

- *Intersection #6 (US 56/Old US 56):* The improvements include signalization and widening of the Old US 56 approach to provide a second left-turn lane.
- *Intersection #21 (I-35 Southbound Ramps/Gardner Road):* The major improvement assumed at the interchange is widening the Gardner Road overpass to provide a 4-lane bridge (plus turn lanes). At Intersection 21, this would allow restriping to convert the outside southbound right-turn lane to a shared through/right-turn lane.
- *Intersection #22 (I-35 Northbound Ramps/Gardner Road):* With the widened Gardner Road bridge, the southbound approach would provide two through lanes and dual left-turn lanes (with the northbound on-ramp widened to accept them). The improvements also assume construction of a northbound right-turn lane.
- *Intersection #23 (Gardner Road/191st Street south):* The improvements include installation of a traffic signal.

<u>2030 Gardner No Action Freeway and Ramp Analysis</u>
The 2030 No Action freeway analysis assumed the forecasted volumes shown in Figure 3-10 and the projected 2030 mainline and ramp geometry (including mainline widening of I-35 to six lanes north of US 56). The resulting operational analysis (for both mainline and ramp junctions) is summarized in Table 3-12.

With the forecasted traffic increases described in the previous section, one freeway segment (I-35 northbound between US 56 and 151st Street) is projected to operate below the acceptable LOS threshold under 2030 No Action conditions:

- *I-35 mainline, US 56 to 151st Street:* This segment was projected to just exceed the LOS E threshold in the northbound direction during the a.m. peak hour without constructing the Proposed Action. This result suggests that additional capacity on this portion of I-35 may be required to accommodate long-term traffic volumes; however, no additional capacity has been planned in the LRTP.

Table 3-12: 2030 Gardner No Action Freeway Operational Analyses

Location	Lanes	AM Peak Hour Density (pc/mi/ln)	AM Peak Hour LOS	PM Peak Hour Density (pc/mi/ln)	PM Peak Hour LOS
Basic Freeway Segments					
I-35 NB					
Sunflower to Waverly	2	24.5	C	13.4	B
Waverly to Gardner	3	17.9	B	11.2	B
Gardner to US 56	3	24.1	C	15.5	B
US 56 to 151st Street	3	**35.3**	**E**	23.5	C
I-35 SB					
151st St to US 56	3	19.2	C	33.3	D
US 56 to Gardner	3	12.8	B	26.5	D
Gardner to Waverly	3	9.3	A	19.2	C
Waverly to Sunflower	2	11.0	B	28.0	D
Ramp Merge/Diverge					
I-35 NB					
Waverly Road Off	N/A	26.1	C	13.2	B
Waverly Road On	N/A	19.9	B	13.0	B
Gardner Road Off	N/A	19.3	B	11.7	B
Gardner Road On	N/A	28.5	D	19.0	B
US 56 Off	N/A	26.0	C	17.1	B
US 56 EB on-loop	N/A	34.7	D	26.2	C
US 56 WB on	N/A	31.6	D	24.3	C
I-35 SB					
US 56 Off	N/A	9.8	A	19.0	B
US 56 On	N/A	14.3	B	28.5	D
Gardner Road Off	N/A	15.1	B	29.5	D
Gardner Road On	N/A	10.0	B	20.5	C
Waverly Road Off	N/A	10.0	A	21.1	C
Waverly Road On	N/A	12.2	B	29.3	D

Notes: pc/mi/ln – passenger cars per mile per lane, LOS – Level of Service.
Bold indicates a LOS below the acceptable threshold.

3.2.4 2030 Gardner IMF Operations

2030 Gardner IMF Operations Forecasts

The 2030 trip generation approach for the intermodal facility was identical to that of the 2015 scenario, only with a higher annual lift count (870,000 in 2030 as compared to 495,000 in 2015) resulting in more trips – a total of nearly 6,045 vpd, including 563 during the a.m. peak hour and 388 during the p.m. peak hour. Table 3-13 summarizes the 2030 trip generation assumptions. The IMF trip distribution and assignment process employed the OTM and combined the results of surveys and other data to distribute truck traffic for the analysis. Additional information on the daily and peak hour trip generation and distribution is provided in Appendix A.

Table 3-13: 2030 Gardner IMF Operations Trip Generation

	Daily	AM Peak Hour in	AM Peak Hour out	AM Peak Hour total	PM Peak Hour in	PM Peak Hour out	PM Peak Hour total
Trucks	3,121	68	103	171	120	94	214
Bobtails	2,233	49	73	122	86	67	153
Non-Trucks	691	135	135	270	7	14	21
Total	6,045	252	311	563	213	175	388

Note: Bobtails are not typically measured at existing IMFs. A conservative estimate was calculated to capture potential bobtail traffic. Actual bobtail trips are likely to be less than what has been projected as trips will be generated by lifts and container staging.

The 2030 Gardner IMF Operations ADT and peak hour forecasts are illustrated in Figures 3-12 and 3-13 and the peak hour truck percentages are presented in Appendix C. The operational analysis for this scenario was conducted based on the 2030 Improved No Action geometry and the 2030 Gardner IMF Operations traffic volumes. The resulting LOS for all study locations are discussed in the following sections.

Figure 3-12: 2030 Gardner IMF Operations ADTs

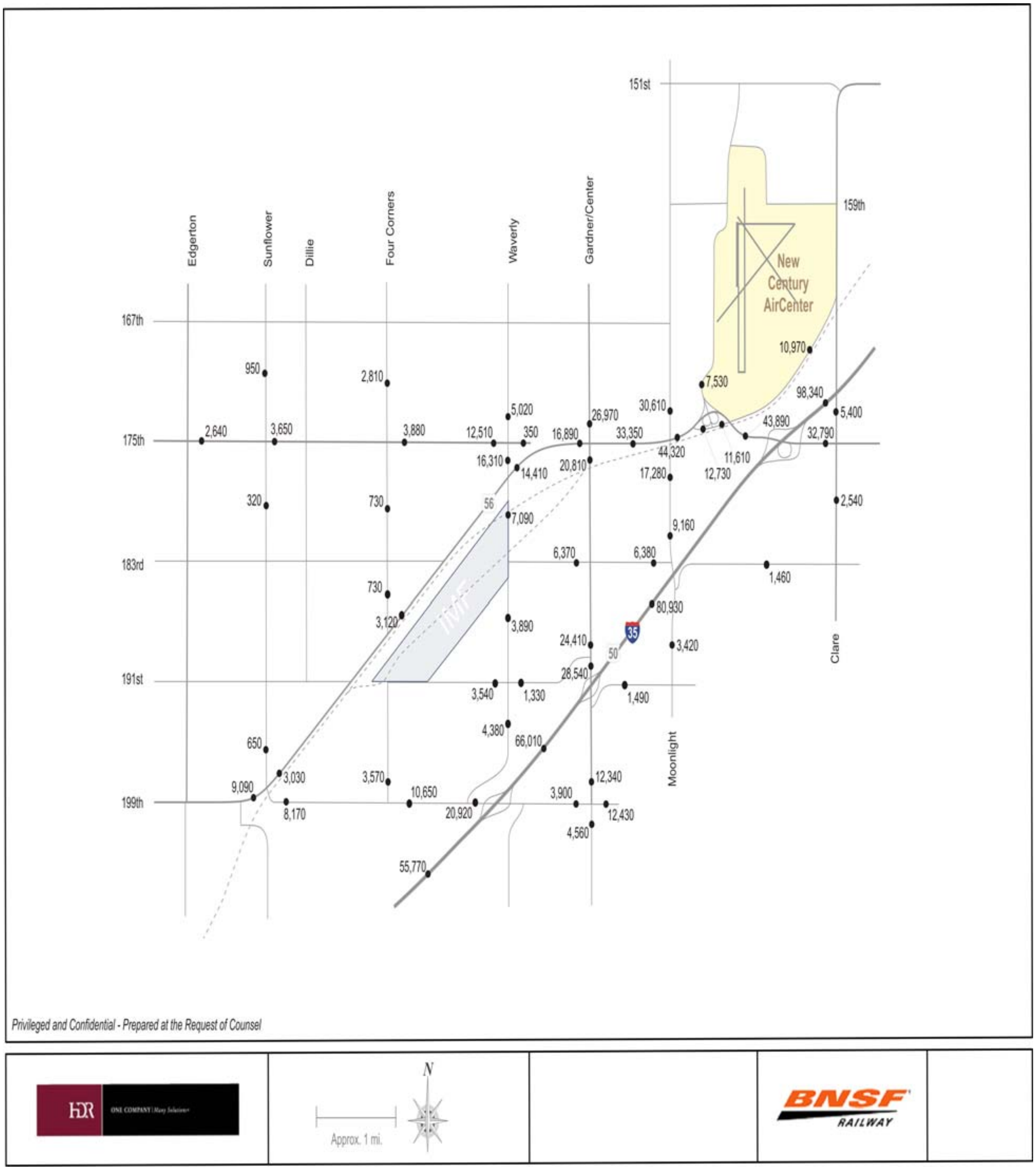
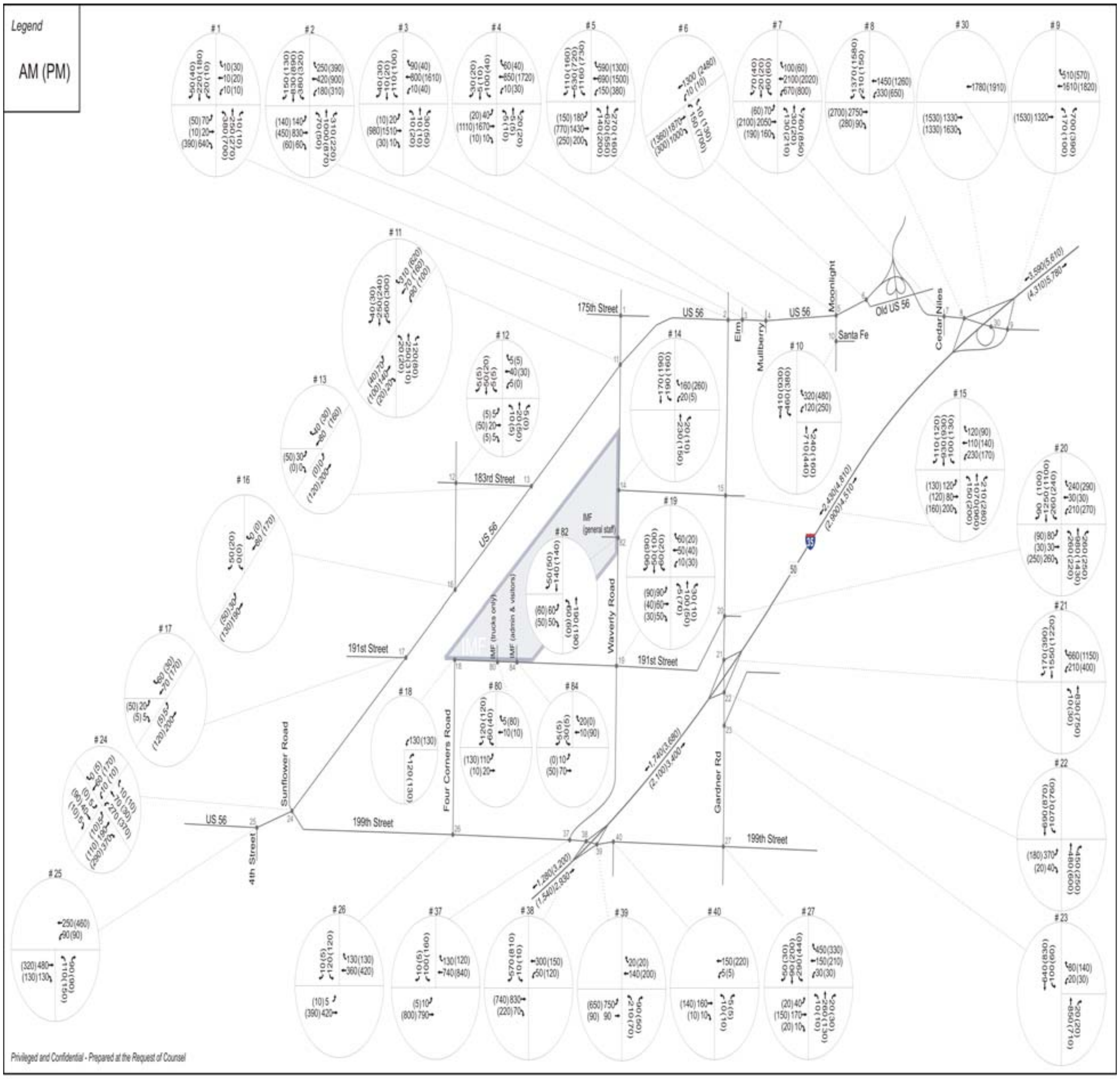


Figure 3-13: 2030 Gardner IMF Operations Turning Movement Volumes



2030 Gardner IMF Operations Intersection Analysis

Table 3-14 summarizes the results of the intersection analysis for this scenario. As the table indicates, the three intersections that were projected to operate below the acceptable LOS threshold under the Improved No Action scenario are projected to continue to operate at the same LOS with the addition of the Proposed Action and associated indirect effects, with generally minor changes in delay. Because these intersections were predicted to experience LOS below the acceptable threshold without the Proposed Action, impacts to these intersections from the Proposed Action are considered to be minor. However, two additional intersections were predicted to operate below the acceptable threshold at LOS E or F:

- *Intersection #26 (199th Street/Four Corners Road)*: The southbound approach to the intersection is projected to operate at LOS E during the a.m. peak hour, and LOS F during the p.m. peak hour.
- *Intersection #37 (199th Street/Waverly Road):* The southbound approach to this future intersection is projected to operate at LOS E during the p.m. peak hour.

These LOS conditions are considered to be moderate impacts in 2030.

Table 3-14: 2030 Gardner Improved No Action and Future IMF Operations Study Intersection Analysis

			Improved No Action				**Proposed Action**			
			AM Peak hr		**PM Peak hr**		**AM Peak hr**		**PM Peak hr**	
	Location	**Traffic Control**	**Delay (sec/veh)**	**LOS**	**Delay**	**LOS**	**Delay**	**LOS**	**Delay**	**LOS**
1	175th St/ Waverly Rd	Sig	19.0	B	15.4	B	20.6	C	15.8	B
2	US 56/ Gardner Rd	Sig	29.1	C	27.2	C	31.0	C	31.8	C
3	US 56/ Elm St	Sig	6.7	A	8.2	A	6.9	A	8.2	A
4	US 56/ Mulberry St	Sig	5.6	A	4.4	A	5.6	A	4.6	A
5	US 56/ Moonlight Rd	Sig	105.9	F	111.4	F	107.8	F	121.4	F
6	US 56/ Old US 56	Sig	13.7	B	24.9	C	14.6	B	28.3	C
7	US 56/ Cedar Niles	Sig	36.7	D	60.4	E	37.7	D	60.9	E
8	I-35 SB Ramps/ US 56	Sig	119.3	F	184.3	F	116	F	185.4	F
9	I-35 NB Ramps/ US 56	Sig	21.0	C	12.5	B	20.4	C	12.7	B
10	Moonlight Rd/ Santa Fe	Sig	22.1	C	19.3	B	22.7	C	19.9	B
11	US 56/ Waverly Rd	Sig	25.8	C	34	C	27.5	C	36.7	D
12	183rd St/ Four Corners	AWSC	8.4	A	8.6	A	7.4	A	7.4	A
13	183rd St/ US 56	TWSC	12.4 (WB)	B	13.4 (EB)	B	10.5 (EB)	B	10.7 (EB)	B
14	183rd St/ Waverly Rd	TWSC	12.0 (NB)	B	13.0 (SB)	B	12.6 (WB)	B	11.2 (WB)	B
15	183rd St/ Gardner Rd	Sig	24.6	C	18.9	B	25.7	C	30.5	C
16	US 56/ Four Corners	TWSC	15.8 (SB)	C	18.2 (NB)	C	8.9 (SB)	A	9.2 (SB)	A
17	191st St/ US 56	TWSC	11.0 (EB)	B	11.4 (EB)	B	10.2 (EB)	B	10.8 (EB)	B
18	191st St/ Four Corners	OWSC	10.3 (WB)	B	10.0 (WB)	B	Does not	exist	Does not	exist
19	191st St/ Waverly Rd	TWSC	10.0 (SB)	A	10.8 (SB)	B	14.9 (SB)	B	22.8 (NB)	C
20	Gardner Rd/ 188th St	Sig	24.3	C	37.6	D	25.9	C	37.9	D
21	I-35 SB / Gardner Rd	Sig	13.1	B	24.3	C	12.9	B	25.3	C
22	I-35 NB / Gardner Rd	Sig	39.9	D	21.1	C	42.4	D	28	C
23	Gardner Rd/ E 191st St	Sig*	6.3*	A	9.5*	A	6.5	A	9.6	A
24	US 56/ Sunflower Rd	Sig	19.0	B	19.3	B	18.7	B	27.1	C
25	US 56/ E 4th St	Sig	10.9	B	11.7	B	11.2	B	12.3	B
26	199th St/ Four Corners	OWSC	20.0 (SB)	C	20.8 (SB)	C	44.5 (SB)	E	51.7 (SB)	F
27	199th St/ Gardner Rd	Sig	27.0	C	21.7	C	27	C	23.2	C
37	199th St/Waverly Rd	OWSC	16.9 (SB)	C	21.1 (SB)	C	32.5 (SB)	D	47.6 (SW)	E
38	199th St/I-35 SB	Sig	16.5	B	21.1	C	22.6	C	48.4	D
39	199th St/I-35 NB	Sig	14.0	B	7.7	A	22.7	C	9.5	A
40	199th St/Waverly Rd	OWSC	10.6 (NB)	B	11.1 (NB)	B	10.2 (NB)	B	10.5 (NB)	B
80	IMF (Truck Entr)	--	--	--	--	--	13.5(SB)	B	14.4(SB)	B
82	IMF (Gen Staff Entr)	--	--	--	--	--	13.3(EB)	B	10.9(EB)	B
84	IMF (Admin Entr)	--	--	--	--	--	9.2(SB)	A	9.0(SB)	A

Notes: TWSC – Two-way STOP control, OWSC – One-way STOP control, AWSC – All-way STOP control, LOS – Level of Service.
Bold indicates a LOS below the acceptable threshold.
For one and two-way STOP-controlled intersections the delay and LOS for the worst approach is shown.

<u>2030 Gardner IMF Operations Freeway/Ramp Analysis</u>

Table 3-15 summarizes the results of the 2030 Gardner IMF Operations freeway analysis. As the table indicates, the one segment previously forecasted to operate at LOS E under 2030 No Action condition (I-35 from US 56 to 151st Street) is expected to continue to operate at LOS E in the 2030 Gardner IMF Operations scenario (with a 5 percent increase in density). This is considered a minor impact from the Proposed Action. In addition, the US 56 eastbound on-loop to I-35 is predicted to degrade from LOS D to LOS E during the a.m. peak hour. With the Proposed Action and associated indirect effects, the density in this merge area is forecasted to increase from 34.7 to 35.5, just crossing the LOS E threshold. Any capacity improvements that would address the northbound mainline LOS E identified in the 2030 No Action scenario would also improve this merge area to acceptable LOS resulting in a minor impact. As previously mentioned, no capacity improvements for this area are currently programmed in the LRTP. However, because this area would fail under the No Action scenario, these LOS issues are not considered to be significant impacts from the Gardner IMF.

In summary, although the analysis identified LOS degradation to LOS E for one ramp in comparison to the 2030 No Action scenario, the LOS would increase to acceptable levels with the improvements required to bring the No Action scenario to acceptable levels of service, and no other freeway or ramp mitigation measures are recommended.

Table 3-15: 2030 Gardner IMF Operations Freeway/Ramp Analysis

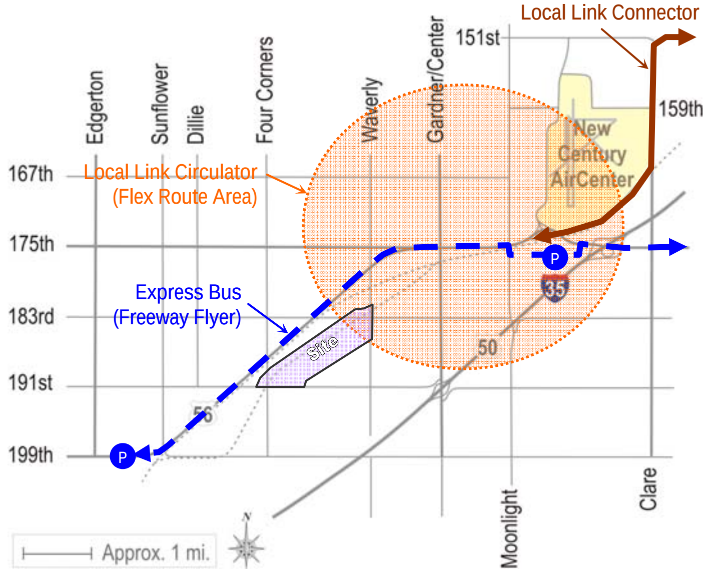
Location	Lanes	AM Peak Hour Density (pc/mi/ln)	AM Peak Hour LOS	PM Peak Hour Density (pc/mi/ln)	PM Peak Hour LOS
Basic Freeway Segments					
I-35 NB					
Sunflower to Waverly	2	24.6	C	13.0	B
Waverly to Gardner	3	19.0	C	11.9	B
Gardner to US 56	3	25.5	C	16.3	B
US 56 to 151st Street	3	**37.2**	**E**	24.2	C
I-35 SB					
151st St to US 56	3	20.1	C	35.0	D
US 56 to Gardner	3	14.0	B	27.6	D
Gardner to Waverly	3	10.1	A	20.5	C
Waverly to Sunflower	2	11.1	B	27.1	D
Ramp Merge/Diverge					
I-35 NB					
Waverly Road Off	N/A	26.2	C	13.2	B
Waverly Road On	N/A	23.0	C	15.9	B
Gardner Road Off	N/A	20.4	C	12.9	B
Gardner Road On	N/A	29.6	D	20.1	C
US 56 Off	N/A	26.9	C	18.3	B
US 56 EB on-loop	N/A	**35.5**	**E**	27.1	C
US 56 WB on	N/A	32.4	D	25.4	C
I-35 SB					
US 56 Off	N/A	10.4	B	20.0	C
US 56 On	N/A	15.3	B	29.6	D
Gardner Road Off	N/A	16.4	B	30.4	D
Gardner Road On	N/A	10.8	B	22.1	C
Waverly Road Off	N/A	11.6	B	23.8	C
Waverly Road On	N/A	12.6	B	30.0	D

Notes: pc/mi/ln – passenger cars per mile per lane, LOS – Level of Service.

3.2.5 Transit

No Action

Figure 3-14: Long-Term Planned Transit Service



In the No Action scenario, no new transit service is expected to be provided to the development site vicinity in the short-term. However, the Regional Transit Plan (Smart Moves) includes long-term plans for extending the peak-period bus service south on US 56 to Edgerton and the addition of a new park-and-ride facility in Edgerton. These planned services are illustrated in Figure 3-14. The express bus service would come into the area on 175th Street (from US 169 and a transit center proposed for southern Olathe) and would continue on US 56 west to Edgerton (through Gardner). A local link circulator in the Gardner area is also proposed in the Smart Moves plan. The circulator would provide local service on weekdays (peak and midday) and weekends, but may not serve the Intermodal Facility area. Additionally, the plan shows a potential local link connector bus service running from the Gardner area to Olathe on Old US 56 and 151st Street.

Gardner Proposed Action and Future Gardner IMF Operations

Two types of transit service impacts are evaluated including: 1) increased demands on existing or planned service, and 2) demands for new service to serve the new development.

Regarding increased demands on existing or planned services, none of the employees are expected to use bus transit service on opening day as there is currently no transit service in the vicinity of the site. Furthermore, the two bus routes serving Gardner only provide peak period/peak direction service to Downtown Kansas City, Missouri. There is no service during off-peak periods, and even during the peak periods there is no service into Gardner in the morning or out of Gardner in the afternoon.

In the future, if the transit plans envisioned for the area are implemented, the peak period service would extend south on US 56 to Edgerton and a local circulator would be implemented in Gardner. The peak-period service would still not serve the intermodal site well, but the circulator could be designed with a stop at or near one or more of the site gates. However, the demand on either of these services related to the intermodal site is expected to be minimal for a number of reasons. One reason is that the off-peak, two-shift/three-shift nature of the work makes using transit for both trip ends difficult. For example, approximately 80 percent of the employees are expected to work a 12-hour two-shift schedule with employees either starting or ending a shift at 7:00 p.m., a time period that typically has low-frequency bus service in low-density areas. In addition, the lack of regional service coinciding with the shift-change peaks means that only local Gardner-area employees using the circulator route would really be able to access the site by bus.

In addition to the issues of shift-change schedules, bus routes/frequencies, and stop locations, there would be the larger issue of overall demand and the provision of bus service to a low-density employment site. The IMF site would have a low employment density with approximately 70 local employees on site during any one shift in 2010 (135 in 2030). This equates to an employment density of approximately one employee per 7.0 acres in 2010 and one employee per

3.5 acres in 2030. These employment densities are not typically consistent with the provision of regular scheduled bus service. In fact, service to these types of sites can have considerable cost, travel time, and delay implications for the service provider and other riders.

Therefore, no impacts are expected to the current or proposed transit service due to increased demand and no significant demand for new bus service is anticipated.

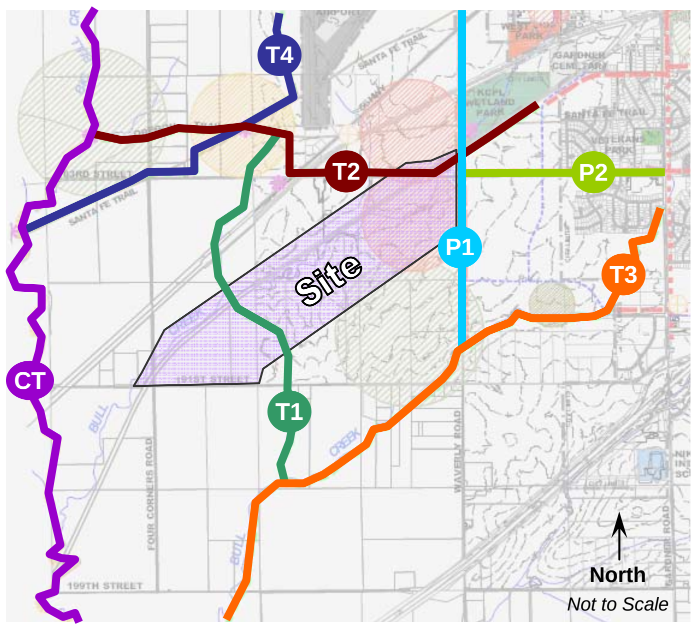
3.2.6 Pedestrian/Bicycle

<u>No Action</u>

Johnson County and City of Gardner documents were reviewed to determine if any new pedestrian and/or bicycle facilities are proposed for the area of the Intermodal site (Johnson County, 2004; Johnson County, 2001; City of Gardner, 2005a; City of Gardner, 2005b).

According to the *Johnson County Rural Comprehensive Plan Update* (2004) and the Johnson County Park and Recreation District *MAP 2020 - Master Action Plan* (2001) a potential trail is being considered along Big Bull Creek. It is shown and labeled as Trail CT in Figure 3-15. The trail would cross US 56 and the northern BNSF mainline track just west of the US 56 / 191st Street intersection. From there, the trail would follow the creek south into Big Bull Creek Park, crossing the existing southern BNSF mainline near 199th Street. According to *MAP 2020*, the Big Bull Creek Trail project would be implemented in the last four years of the 20-year park plan.

Figure 3-15:
Potential Future Trails



The City of Gardner Arterial Concept Pathway Plan map (dated June 2005) shows four potential future trails in the vicinity of the site. The first trail (T1) would run generally north-south in the vicinity of the Gardner site. It would cross US 56 and both the northern and southern BNSF mainlines approximately one-half mile east of Four Corners Road. It would then proceed south to cross 191st Street approximately two-thirds of a mile east of Four Corners Road. The second trail (T2) would run east-west along 183rd Street and the southern BNSF mainline between US 56 and Waverly Road. This trail would cross both BNSF mainline tracks. The third trail (T3) would run northeast-southwest near the Gardner site. It would cross Waverly Road just north of 191st Street and then cross 191st Street just west of Waverly Road. Trail T3 would continue south toward Big Bull Creek Park. The fourth trail (T4) would be located north of US 56 and would generally run northeast-southwest. It would follow a portion of the Old Santa Fe Trail between trails T2 and CT.

In addition to the above trails, two arterial pathways/bike routes are proposed: one along Waverly Road between US 56 and Trail T3 (P1), and one along 183rd Street (P2). These pathways are similar to paved trails or wide sidewalks, but they would be designed as joint-use facilities to serve both pedestrians and bicycles.

The City of Gardner plans to update its Trails and Pathways Plan as well as its Transportation Master Plan this year (2008). Based on communications with City staff, it is expected that major changes will be made to the proposed trails and pathways in the vicinity of the Proposed Action, and modified or additional pedestrian or bicycle facilities (such as bike lanes or routes) may be developed.

When the proposed new I-35 interchange is open to traffic, traffic on both Waverly Road and 199th Street is expected to increase. In order to provide for adequate pedestrian circulation and safety on these roadways, sidewalks, arterial pathways (such as the extension of the Waverly pathway), or paved shoulders (8-foot minimum) may be desirable in the longer-term No Action scenario.

<u>Proposed Action and Future Gardner IMF Operations</u>

The analysis presented in this section considered the potential pedestrian, bicycle, and trail activity or demand associated with the Proposed Action and the physical relationship of the Proposed Action to existing and proposed pedestrian, bicycle, and trail facilities.

In the near-term, pedestrian traffic to and from the IMF (i.e., off-site) is expected to be minimal. The primary reason for this is the long walk distances between the Proposed Action and most residential or retail destinations. The nearest subdivision entrance is nearly one mile from the main employee gate and even further from the actual on-site building locations. Second, as outlined previously, the number of on-site employees would be modest (under 70 on opening day and approximately 135 in 2030). A third reason is the off-peak two-shift/three-shift nature of the work. As mentioned in the transit section, approximately 80 percent of the on-site employees would work 12-hour shifts with shift changes at 7:00 a.m. and 7:00 p.m. This would mean that employees would have to walk after dark during a portion of the year.

Pedestrian activity may increase in the future if new development occurs within walking distance of the Proposed Action, but given the number of employees and the nature and dispersion of the on-site activity, it is not expected to be a major transportation mode for the site. The pedestrian activity that does result from the Proposed Action would principally be accommodated on the sidewalk proposed for 191st Street and the 8-foot shoulders proposed for Waverly Road. The provision of either sidewalks or full (8-foot) shoulders is important given the volume of Proposed Action truck traffic expected, especially on 191st Street. The planned arterial pathways (trails) on Waverly Road and 183rd Street could provide improved pedestrian access and safety when they are implemented. Based on contact with TAG-KC, the entity responsible for improving Waverly Road and 191st Street in the vicinity of the Proposed Action, the need for incorporating trail facilities along these roads is being coordinated with the City of Gardner and agreed upon provisions will be incorporated into the designs based on the updated trail plan (TAG-KC, 2008). This is consistent with the City street standards which state, "The design engineer shall contact the Parks and Recreation Department, Public Works, and/or Planning Department to determine whether any portion of the proposed construction will involve the City of Gardner's Trail System. Sidewalks constructed as part of this system shall be 10 feet in width with a 25-foot wide pedestrian easement."

Another consideration is the future construction of a new interchange on I-35. The main routes to this interchange (e.g., Waverly Road, and 199th Street) would benefit from either sidewalks or 8-foot minimum paved shoulders when that interchange is open to traffic. This could be addressed in the KDOT NEPA assessment of the new interchange and considered as part of that project's mitigation if warranted. It would also be beneficial if the City's proposed arterial pathway on Waverly Road were constructed (and extended further south) prior to the opening of the new interchange due to the increase in traffic on Waverly Road associated with the new interchange.

Bicycle activity is expected to be minimal for the same reasons that pedestrian activity is expected to be minimal. Special provision of bicycle routes or lanes is not typically necessary for this type of land use. In the near-term, any bicycle activity associated with the IMF would be adult work-based trips, and these trips could be accommodated on the planned paved roadways (or sidewalks on 191st Street). In the longer term, the new arterial pathways on Waverly Road and 183rd Street would also be available. When the new I-35 interchange is constructed, it may be beneficial to have bicycle provisions in place on roadways serving this interchange, including an extension of the City's planned arterial pathway on Waverly Road.

There are no existing facilities that would be physically impacted by the Proposed Action; however, the Proposed Action could affect some of the proposed facilities previously described. The City of Gardner has indicated that they expect to initiate a new Master Plan for trails and pathways later this year (City of Gardner, 2008a). City staff has indicated they expect major changes to the proposed trails and pathways in the vicinity of the Proposed Action to eliminate potential impacts. Therefore, the following potential impacts are expected to be resolved through the completion of the new Master Plan update:

- *Big Bull Creek Trail (CT)* – This trail would no longer have two separate railroad crossings. With the consolidation of the northern and southern BNSF mainline tracks into one right-of-way, a single larger structure could be used to cross all of the BNSF tracks (mainline and intermodal lead tracks).
- *Gardner Trail 1 (T1)* – The proposed north-south trail that would traverse through the project site would need to be rerouted, shortened, or eliminated because it would not be able to pass through the center of the intermodal site. There are other routing options, such as following US 56 south to the Big Bull Trail and then crossing US 56 and the railroad tracks in unison with that trail. This would allow the benefits of cost-sharing for construction of the crossing.
- *Gardner Trail 2 (T2)* – The proposed east-west trail along 183rd Street would also cut through the project site. It would need to be rerouted, shortened, or eliminated. One option would be to reroute the trail north along US 56, to connect with the pathway along Waverly Road. This would eliminate new railroad crossings and would make use of the proposed grade separation over the intermodal lead tracks on Waverly Road.
- *Pathway on Waverly Road (P1)* - The proposed pathway along Waverly Road could still be implemented as planned; however, use of the grade separation over the intermodal lead tracks on Waverly Road could be considered. As previously mentioned in the No Action section, special treatments for the path's at-grade crossing on Waverly Road may also be required (e.g., marked crossing, pedestrian scale signs, or guide fencing). Also, as mentioned previously, there is ongoing coordination between the roadway planners and the City regarding if and where trail facilities are needed along Waverly Road and 191st Street consistent with the update of the Master Plan.

3.2.7 At-Grade Rail-Highway Crossings and Delay

<u>No Action</u>

In the No Action alternative, the BNSF mainline train volumes would increase from 72 trains per average weekday in 2010 to 114 in 2030 as shown in Table 3-16. In addition, the train lengths are projected to increase over this time period. These changes would lead to increased blocked times and increased vehicular delay at all of the at-grade highway-rail crossing locations. As indicated in Table 3-17, the average blocked time per train would increase to just over three minutes per train by 2015. The average total blocked times are projected to be approximately 8:47 (min:sec) per hour in 2010, 9:56 per hour in 2015, and 15:14 per hour in 2030. These blocked time estimates are independent of the highway traffic volumes and are based on two at-grade crossings per roadway as outlined previously.

Table 3-16: Gardner Estimated Trains Per Weekday

	Avg. Weekday Trains (Tues – Thurs)		
Year	*2010*	*2015*	*2030*
No Action	72	78	114
Proposed Action			
North of Site	68	73	104
Mainline by Site	67	72	102
South of Site	72	78	114

Table 3-17: Rail Crossing Volumes, Blocked Times, and Delay Summary

			Traffic Volume (veh/hr)						Delayed Vehicles (veh/hr)						Avg. Block Time Per Train (min:sec)			Avg. Blocked Time Per Hour (min:sec)			Avg. Delay Per Vehicle (sec)						Avg. Delay Per *Delayed* Vehicle (sec)					
			AM			PM			AM			PM			Weekday Peak Hour			Weekday Peak Hour			AM			PM			AM			PM		
	Mile		2010	2015	2030	2010	2015	2030	2010	2015	2030	2010	2015	2030	2010	2015	2030	2010	2015	2030	2010	2015	2030	2010	2015	2030	2010	2015	2030	2010	2015	2030
No Action	33.52	Moonlight	660	760	1910	940	1090	2220	108	143	691	165	223	893	2:55	3:03	3:13	8:47	9:56	15:14	15	18	36	16	19	40	90	94	101	89	93	100
	35.61	Waverly	30	35	240	25	25	310	4	6	66	4	4	87	2:55	3:03	3:13	8:47	9:56	15:14	13	16	28	13	16	28	90	94	100	90	95	101
	36.49	183rd	45	45	90	35	50	130	7	8	24	5	8	34	2:55	3:03	3:13	8:47	9:56	15:14	13	16	26	13	16	27	90	94	100	90	93	101
	37.46	Four Corners	35	35	385	30	35	390	5	6	111	4	6	113	2:55	3:03	3:13	8:47	9:56	15:14	13	16	29	13	16	29	90	94	100	90	94	100
	38.01	191st	20	20	40	10	10	35	3	3	10	1	2	9	2:55	3:03	3:13	8:47	9:56	15:14	13	16	26	13	16	26	88	93	100	92	97	101
	39.4	199th	100	100	695	70	80	720	15	17	228	10	14	235	2:55	3:03	3:13	8:47	9:56	15:14	14	16	33	13	16	33	89	93	100	90	94	101
	39.77	Nelson	180	310	565	220	275	645	29	57	175	35	50	206	2:55	3:03	3:13	8:47	9:56	15:14	14	17	31	14	17	32	89	94	100	90	95	100
	40.7	207th	130	150	350	120	150	380	21	27	102	18	26	109	2:55	3:03	3:13	8:47	9:56	15:14	14	17	29	14	16	29	88	92	99	91	95	101
	41.2	Edgerton	10	15	15	20	25	35	1	2	4	3	4	9	2:55	3:03	3:13	8:47	9:56	15:14	13	16	26	13	16	26	90	95	102	90	93	101
With IMF	33.52	Moonlight	660	760	1900	940	1090	2220	102	134	631	156	209	820	2:56	3:05	3:14	8:18	9:19	13:60	14	17	34	15	18	37	90	95	101	90	94	100
	35.61	Waverly	50	90	750	35	50	770	7	14	225	5	8	233	2:56	3:04	3:14	8:11	9:10	13:47	12	15	30	12	15	30	90	95	101	90	95	101
	36.49	183rd																														
	37.46	Four Corners																														
	38.01	191st																														
	39.4	199th	100	120	770	80	90	800	16	22	277	13	16	289	3:04	3:13	3:26	9:13	10:28	16:16	15	18	39	15	18	39	95	100	109	95	101	109
	39.77	Nelson	180	310	565	220	275	645	30	60	184	36	52	217	3:02	3:11	3:23	9:09	10:23	16:05	15	19	35	15	19	36	94	99	107	95	100	107
	40.7	207th	130	150	350	120	150	380	21	28	105	19	27	112	2:59	3:07	3:18	8:59	10:10	15:40	15	18	31	14	17	31	91	95	102	93	98	104
	41.2	Edgerton	10	15	15	20	25	35	1	2	4	3	4	9	2:56	3:04	3:14	8:51	10:00	15:21	13	16	26	13	16	26	90	95	102	90	94	101
Change	33.52	Moonlight	0	0	-10	0	0	0	-6	-9	-60	-9	-14	-73	0:01	0:01	0:02	-0:29	-0:37	-1:14	-1	-1	-3	-1	-1	-3	1	1	0	1	1	1
	35.61	Waverly	20	55	510	10	25	460	2	8	159	1	4	146	0:01	0:01	0:01	-0:37	-0:46	-1:27	-1	-1	3	-1	-1	2	0	0	0	0	0	0
	36.49	183rd																														
	37.46	Four Corners																														
	38.01	191st																														
	39.4	199th	0	20	75	10	10	80	1	5	49	2	3	54	0:09	0:10	0:13	0:26	0:32	1:02	2	2	6	2	2	7	6	7	9	6	7	9
	39.77	Nelson	0	0	0	0	0	0	1	3	10	1	2	11	0:07	0:08	0:11	0:22	0:27	0:52	1	2	4	1	2	4	5	5	7	5	5	7
	40.7	207th	0	0	0	0	0	0	0	1	3	0	1	3	0:04	0:04	0:05	0:11	0:14	0:26	1	1	2	1	1	2	3	3	3	2	2	3
	41.2	Edgerton	0	0	0	0	0	0	0	0	0	0	0	0	0:01	0:01	0:01	0:03	0:04	0:07	0	0	0	0	0	0	0	0	0	0	0	0

The number of delayed vehicles would increase over this 20-year period due to both increasing train and highway vehicle volumes. In the 2030 No Action scenario, approximately 25 to 40 percent of the highway vehicles at each crossing would be delayed to some extent, with the highest percentage at the Moonlight Road crossing.

Average vehicle crossing delays are projected to increase as well. The average vehicle delay for all vehicles would be approximately 13 to 16 sec/veh in 2010, increasing to 26 to 40 sec/veh in 2030 for the No Action Alternative. The average delay to delayed vehicles (i.e., average delay for vehicles present when a train is present) would not increase quite as much, from approximately 90 seconds in 2010 to 100 seconds per delayed vehicle in 2030. However, there would also be more delayed vehicles in 2030.

<u>Proposed Action and Future Gardner IMF Operations</u>
Changes to the at-grade crossings as a result of the Proposed Action include the following:

1. At-grade crossings on 183rd Street, Four Corners Road, and 191st Street would be eliminated due to road closures.
2. Use of the eastern at-grade crossing on 199th Street would be discontinued.
3. Grade separation over the east lead tracks would be constructed on Waverly Road.
4. Total train volumes would decrease at the Waverly Road at-grade crossing and Moonlight Road Crossings.
5. Highway traffic would increase, especially on Waverly Road and 199th Street.
6. Train speeds for intermodal trains entering or departing the Gardner IMF may be reduced (depending on the location and direction).
7. Grade separation over the westbound mainline and relocated eastbound mainline would be constructed on Waverly Road.

With regard to the decrease in total train volumes associated with the Proposed Action, the total number of trains south of the Gardner IMF would remain the same (Table 3-16). However, alongside and north of the IMF (i.e., at the Waverly Road and Moonlight Road crossings), the total number of trains would decrease because the intermodal trains to and from the West Coast (the amount of which exceeds those traveling to and from the east) would stop at the IMF and would not go further east. Because of this difference, the two sets of crossings are discussed separately.

Waverly Road and Moonlight Road Crossings
Based on the four changes previously outlined, the average blocked time per train would remain essentially the same at Moonlight Road and Waverly Road, while the total blocked time per hour would decrease by between 0:29 and 1:27 (min:sec) depending on the year and location (Table 3-17). Due to the reduction in total blocked time, the total number of delayed vehicles would decrease at Moonlight Road. At Waverly Road, the number of delayed vehicles would increase due to increases in highway vehicles at that location. The average delay per vehicle decreases slightly at both locations except in 2030 where it increases by two to three seconds at Waverly Road. The average delay per delayed vehicle at both locations would be about the same as in the No Action scenario.

Other Crossing Locations
For the locations south of the intermodal facility, the blocked time would increase with the Proposed Action as shown in Table 3-17. The blocked time per hour would increase the most on 199th Street, with an increase of 26 seconds to 9:13 per hour in 2010 and an increase of approximately one minute to 16:16 per hour in 2030. The average blocked time per train at 199th Street would be 3:26 in 2030 (13 seconds higher than the No Action condition). The number of delayed vehicles would increase the most on 199th Street (by approximately 50 vehicles during each peak hour in 2030). On 199th Street, delay per vehicle would increase by 6 to 7 sec/veh in 2030, while the delay per delayed vehicle would increase by 9 sec/veh in 2030. The changes to

blocked time and delay on Nelson Street would be somewhat less. Changes to 207th Street and Edgerton Road would be modest to minor and affect very few additional vehicles.

Based on Table 3-17, 199th Street is expected to experience the largest increases in blocked time and crossing delay in comparison to the No Action scenario. The average blocked time increase would be 7 percent in 2030. The average delay increase (for all vehicles) would be 20 percent in 2030; however, the average delay would remain below 40 sec/veh.

The effects of the Proposed Action and Future Gardner IMF Operations in comparison to the No Action scenario are summarized as follows:

- *Moonlight Road* – decrease in total blocked time and delay;
- *Waverly Road* – decrease in total blocked time, delay decrease in 2010 and 2015, delay increase in 2030 due to higher highway volumes;
- *183rd Street*, *Four Corners, 191st Street* – crossings closed;
- *199th Street* – increased blocked time (increase of 1:02 per hour in 2030), increase in delayed vehicles (54 in 2030 p.m. peak), increase in average delay per vehicle (7 sec/veh in 2030 p.m. peak);
- *Nelson Road* – increased blocked time (increase of 0:52 per hour in 2030), increase in delayed vehicles (11 in 2030 p.m. peak), increase in average delay per vehicle (4 sec/veh in 2030 p.m. peak);
- *207th Street* - increased blocked time (increase of 0:26 per hour in 2030), increase in delayed vehicles (3 in 2030 p.m. peak), increase in average delay per vehicle (2 sec/veh in 2030 p.m. peak);
- *Edgerton Road* – minor change.

Overall, the majority of the anticipated blocked time and delay in the Proposed Action scenario would be due to through trains, which are not affected by the Proposed Action. In addition, the forecasted overall average delay per vehicle would never exceed 40 seconds. The average delay to delayed vehicles would increase from around 100 seconds in the No Action scenario to a maximum average value of 109 seconds in 2030 at 199th Street in the Proposed Action scenario. Therefore, delay impacts as a result of the Proposed Action are not considered significant.

3.2.8 Emergency Vehicle Access

No Action

In the No Action scenario, emergency vehicle access routing and distances are expected to remain as outlined in Section 2.1.8 (Figure 2-7). There are, however, two future changes that would affect emergency vehicle access: the volume of train traffic is expected to increase over time and the average length of those trains is expected to increase. These changes would increase the potential for delay (and longer delays) when responding vehicles must cross railroad tracks. The increase in at-grade crossing delay in the No Action scenario is outlined in Section 3.2.7.

Proposed Action and Future Gardner IMF Operations

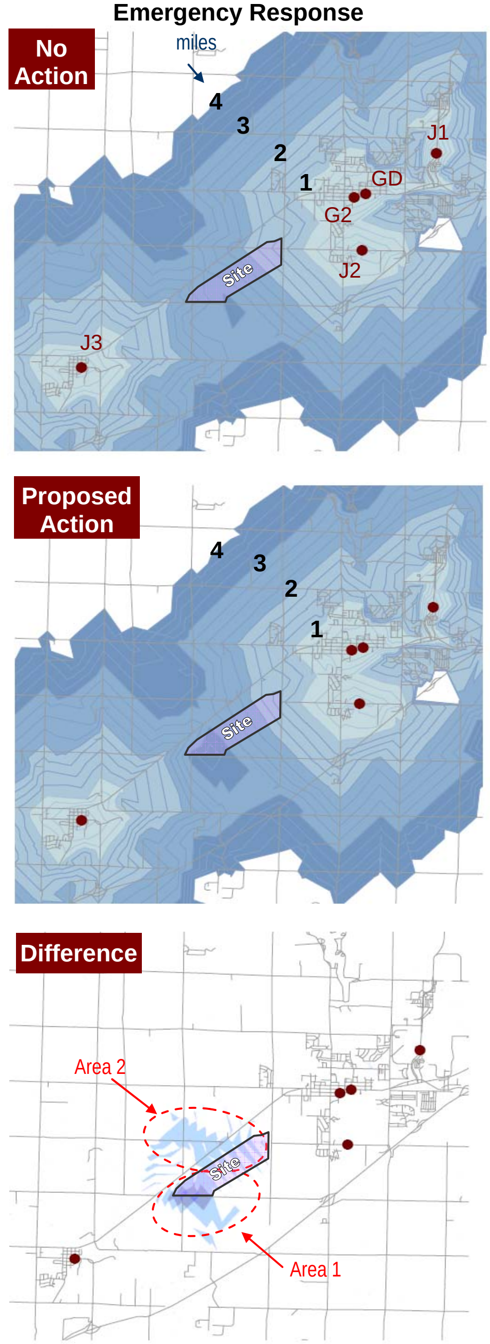
The construction of the Proposed Action would result in changes to the local roadway network as well as to the current railroad track alignment. The modifications that pertain to emergency vehicle access are highlighted here:

- 183rd Street would be closed from US 56 to Waverly Road.
- 191st Street would be closed from US 56 to Four Corners Road.
- Four Corners Road would be closed from US 56 to 191st Street.

- The eastern railroad crossing on 199th Street would be eliminated, and the west crossing would be widened to accommodate additional tracks.
- The northern crossing of Waverly Road would be double tracked and grade separated.
- The southern crossing of Waverly Road (new lead tracks) would be grade separated.
- Train volumes at all but two rail-highway at-grade crossings would remain unchanged, but average train speeds at key locations would change (*At-Grade Rail-Highway Crossings and Delay*, Section 3.2.7).

The aforementioned closures and adjustments would not change the majority of Emergency Vehicle Response EVR distances outlined in the Section 2.1.8. In fact, only two areas would be affected. Figure 3.16 shows the EVR distances with the closures anticipated as part of the Proposed Action. (As on Figure 2-7, the stations shown on Figure 3-16 are: [J1] - Johnson Co. FD No. 1 Station #1, [J2] - Johnson Co. FD1 Station #2, [J3] - Johnson Co. FD1 Station #3, [G2] - Gardner Plum Creek Station #2, and [GD] - Gardner Department of Public Safety). The outer four-mile bands would remain constant and the Proposed Action Site would also remain within four miles of one or more stations. A comparison of the No Action and Proposed Action figures is provided at the bottom of Figure 3-16 and the two areas with changed response distances are described.

Figure 3-16: Change in Distance from Emergency Response



As illustrated, there would be a small area in the vicinity of 191st Street and Four Corners Road (Area 1) where emergency vehicle response distances would increase by 0.25 to 0.5 mile. This change is due to the 191st Street closure, which would make 199th Street the new shortest distance for EVR from the Edgerton Station to this area. Emergency response vehicles from the Gardner area would have a somewhat longer response distance, but they can reach this area without crossing any active rail lines at-grade. In fact, with the relocation of the southern BNSF mainline, stations in Gardner can serve any site east of the tracks without crossing a rail line at-grade. Thus while in some cases the response distances might be longer than from the Edgerton station, the response times would be more certain from Gardner. The potential at-grade highway-rail grade crossing delay associated with the Proposed Action is addressed in Section 3.2.7, *At-Grade Rail-Highway Crossings and Delay*.

There is also an area in the vicinity of 183rd Street, US 56, and Four Corners Road for which the response distances would increase by 0.25 mile (Area 2). This is due to the 183rd Street closure, which would mean that the Gardner Plum Creek Station #2 would no longer be the nearest station. Instead, Johnson County FD No. 1 Station #2 and Johnson County FD No. 1 Station #3 would become the nearest stations. Stations in both downtown Edgerton and Gardner could both respond to this area without crossing any active rail lines at-grade.

A third area of interest, not highlighted because it is not affected by any road closures, is service within Edgerton, specifically, access from Johnson County Fire Station #2 [J3] to areas east of the railroad tracks in the vicinity of Sunflower Road. A review of the expected average train speeds along this corridor shows that outbound intermodal trains (leaving the IMF) would travel slower than typical through trains (on average) at both Nelson Street and 207th Street. Inbound intermodal trains would travel faster on average than through trains at 207th Street, but slower at Nelson Street. Therefore, in 2015, between six and seven times per day there would be trains entering or leaving the IMF that would pass Nelson Street traveling slower than through trains. At 207th Street this would only occur three times per day. The Edgerton Road crossing is far enough south of the IMF that the average inbound IMF-train speed would slightly exceed the average through-train speed; and the outbound IMF-train speed would be slightly slower(within 2 mph) than the average through-train speed.

3.2.9 Circulation System

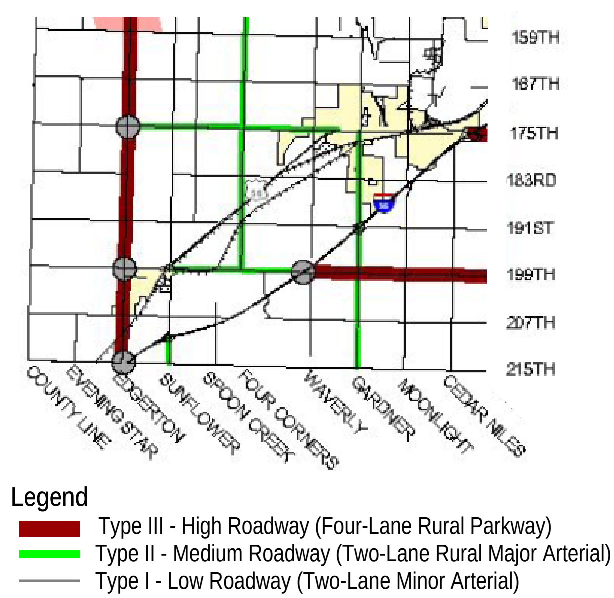
<u>No Action</u>

In the No Action Scenario, the local and regional connectivity would remain similar to what it is today, with the following exceptions:

1. Development would continue in the area. This would likely include more dense development in the areas with water and sewer service.
2. Railroad traffic on the southern transcontinental mainline would continue to increase (as outlined previously), leading to increased potential for delay at mainline railroad crossings.
3. Before 2030 (and as soon as late 2015), a new interchange is planned for I-35 in the vicinity of Waverly Road, 199th Street, or Homestead Lane. The exact location is currently under study by KDOT, but for purposes of this analysis it was assumed to be near 199th Street and Waverly Road as shown on the current County plan.

The Johnson County Comprehensive Arterial Road Network Plan (CARNP) shows future improvements to selected roadways in the vicinity of the Proposed Action (Figure 3-17). The CARNP is the County's principal transportation planning document and was adopted by the County Commissioners in 1999. In addition, the more recent Johnson County Rural Comprehensive Plan (June 2004) adopted the 1999 CARNP as the transportation plan for Southwestern Johnson County. The CARNP shows a new grade-separated access point on I-35 at 199th Street near Waverly Road. It also shows upgrades to 199th Street to provide improved east-west connectivity in the vicinity of the interchange. Specifically, 199th Street is shown as a four-lane rural parkway (Type III - High Roadway) east of I-35. West of I-35, 199th Street is proposed as a two-lane rural major arterial (Type II - Medium Roadway). Four Corners Road, Gardner Road/Center Street, and 175th Street are

Figure 3-17:
Johnson County CARNP – Gardner Area



all shown as two-lane rural major arterials (Type II – Medium Roadway). Waverly Road, 191st Street, and 183rd Street are shown as two-lane minor arterials (Type I – Low Roadway).

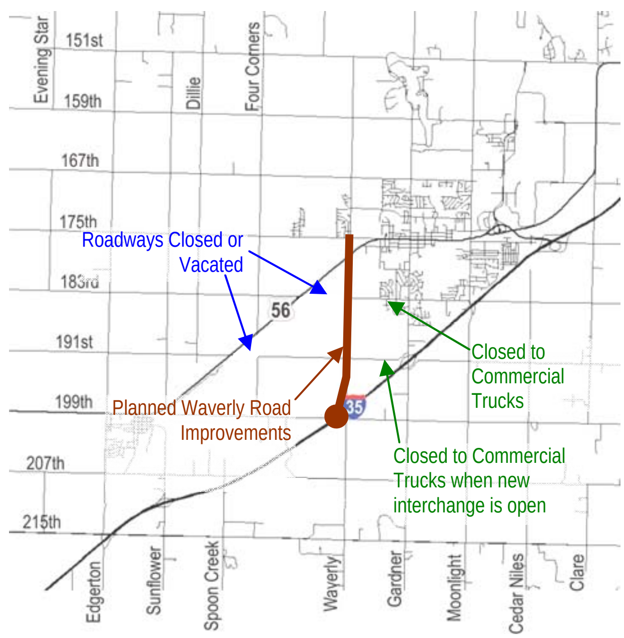
Based on the CARNP, local connectivity in the vicinity of the Proposed Action would be improved by upgrading existing collector roadways to arterials (199th Street, Four Corners Road, Gardner Road, and 175th Street). Two of these roadways are north-south and two are east-west. They all already cross existing barriers. They also strengthen the grid network form (they form a rectangle) south and west of Gardner. Regional connectivity is improved through the addition of a second interchange on 199th Street near Waverly Road. Thus travelers would have two options for interstate highway access: Gardner Road and 199th Street near Waverly Road.

Plans by the City of Gardner and Johnson County to re-align 191st Street to connect with the existing 188th Street roadway section will also modify circulation in the area. It will improve traffic operations on Gardner Road in this area as it will provide significantly more distance between the southbound I-35 interchange ramp intersection and the first major intersection to the north.

<u>Proposed Action and Future Gardner IMF Operations</u>

With the Proposed Action, circulation in the vicinity of the Gardner IMF would be changed in part due to the closure of sections of 191st Street, Four Corners Road, and 183rd Street as shown in Figure 3-18. Closure of these roadways would necessitate that drivers use alternative routes through the area. In addition, 183rd Street (just west of Gardner Road) would be closed to through commercial truck traffic. 191st Street (between Waverly Road and Gardner Road) would also be closed to through commercial truck once the new I-35 interchange is constructed. Therefore, the circulation system for commercial trucks would be somewhat more limited than for autos.

Figure 3-18: Roadway Network Changes



Until the new interchange is constructed, it is recommended that the re-aligned 191st Street/188th Street and Gardner Road be promoted as the main route to and from I-35 for all IMF truck traffic. This could include on and off-site signage directing truck drivers to use this route (and to discourage the use of prohibited routes). It could also include other means by which directions are communicated to truck drivers traveling to and from the IMF. This recommendation would carry forward into the future Gardner IMF Scenarios, with adjustments made as necessary when the new I-35 interchange is constructed. The City of Gardner is considering changes to their current designated truck routes.

As noted, the Proposed Action would eliminate three pieces of the current grid system south and west of Gardner. Currently, Four Corners Road is a collector roadway and the other two are local (gravel) roadways. They all currently carry low traffic volumes (approximately 100 to 250 ADT). The CARNP classifies Four Corners Road in the future as a two-lane rural major arterial (Type II – Medium), while the other two are classified as two-lane rural minor arterials (Type I – Low). The approximate 2030 traffic volumes in the No Action scenario for the road sections proposed for closure are: Four Corners Road – 3,720 ADT, 191st Street - 270 ADT, and 183rd Street – 1,010 ADT. Based on these volumes, it appears that these segments of 191st Street and 183rd

Street would not be critical to the overall highway system in 2030. Four Corners Road, however, would carry a larger amount of traffic.

With the closure of the aforementioned roadways, traffic volumes on 199th Street and Waverly Road are expected to increase in comparison to the No Action scenario. The increase on 199th Street is forecasted to be approximately 530 vpd (6.9 percent) just east of US 56. This would include some traffic from the Gardner IMF. The increase on Waverly Road is expected to be more appreciable as it would become the major alternative to Four Corners Road (This is demonstrated in part by the increase of only 230 vpd on Sunflower Road just north of US 56). Traffic on Waverly Road, a low volume roadway, is forecasted to increase from 2,180 to 7,090 (4,910 vpd, or 225 percent) just south of US 56. Waverly Road would still be able to accommodate the traffic volumes shown in the Proposed Action scenario as a two-lane highway. Some of this increase would be traffic generated by the Proposed Action, but much of it would be local traffic re-routed by the road closures including traffic headed to and from the new interchange on I-35 near Waverly Road. Therefore, with the combination of the Proposed Action and the new interchange, Waverly Road would become a primary arterial highway in the local grid system. These potential shifts in traffic flow and circulation, while considerable, are not anticipated to have a significant negative effect on traffic circulation and connectivity of the area. Regarding, east-west flows, it appears that the traffic from 191st Street and 183rd Street would disperse to various roadways (199th Street, US 56, Waverly Road to 183rd Street), and the Proposed Action street network appears sufficient to accommodate these shifts with minor impacts.

3.2.10 Roadway Design Considerations

<u>No Action</u>

In the No Action Scenario the highway system could be expected to continue to evolve in a manner consistent with past trends. This would include periodic roadway upgrades as needed to meet future state and local roadway design standards. In the immediate vicinity of the IMF, the major improvements expected to be made in the 2010 and 2015 time frames include the KDOT improvements related to Gardner Road. In the 2030 No Action Scenario it is assumed that a number of local roadways would be improved per the CARNP recommendations. This is in keeping with the anticipated development in the area not related to the Proposed Action and the assumption of a new interchange on I-35 serving the 199th Street and Waverly Road corridors. The local roadway improvement could include paving 183rd street, Waverly Road, and 191st Street to bring them up to rural two-lane Type I standards (The example of a rural two-lane Type I roadway given in the CARNP is West 143rd Street, which is a two-lane roadway with minimal shoulders and few if any turn lanes). Based on the CARNP, Four Corners Road and 199th Street would be improved to rural two-lane Type II standards (The example of a two-lane Type II roadway given in the CARNP is 175th Street from I-35 to US 169, which has paved shoulders and turn lanes as needed at major intersections).

<u>Proposed Action and Future Gardner IMF Operations</u>

With the construction of the Gardner IMF, a number of the roads previously anticipated to be upgraded in the longer term would be upgraded in the near term. This would include upgrades to both 191st Street and Waverly Road. These roads would be designed to meet applicable state and local standards, including pavement depth and type appropriate for the projected auto and truck traffic. Separate from the Proposed Action, Gardner Road, which is a local collector roadway, is being improved by KDOT to be four lanes with signals from 188th Street/191st Street south to the I-35 interchange. In the 2010 and 2015 Scenarios, the vast majority of IMF truck traffic is anticipated to use the re-aligned 188th Street/191st Street and Gardner Road to travel to and from I-35. For example, in 2015, 191 out of 209 p.m. peak-hour IMF trucks are forecasted to use this route (over 91 percent). This would minimize any potential near-term effects on other local roadways such as Four Corners Road and 199th Street.

By 2030, a new I-35 interchange between the Cities of Gardner and Edgerton is forecasted to attract the vast majority of IMF truck traffic. IMF trucks would use a combination of the new Waverly Road connection between 191st Street and 199th Street and the Four Corners Connection to 199th Street to reach this interchange, however, a new Waverly Road connection would presumably be built to the appropriate design standards, taking the expected truck usage into account. The CARNP plan calls for improving 199th Street to support forecasted area/corridor development and to facilitate connections to I-35 as mentioned in the No Action Scenario. Therefore, Four Corners Road could experience truck volumes for which it is not designed. However, given the closure of Four Corners north of 191st Street, non-IMF traffic on that roadway is likely to be minimal.

The City's planned re-alignment of 191st Street to connect with 188th Street would also improve safety along Gardner Road in this area as it will provide significantly more distance between the southbound I-35 interchange ramp intersection and the new main access point to the realigned 188th Street/191st Street.

For 2010, 2015, and 2030, there are no anticipated major conflicts between school traffic and IMF truck traffic currently anticipated. For example, in 2015 no IMF trucks are projected to use Gardner Road south of I-35 (in the vicinity of the Nike Elementary School) during the 7:00 to 8:00 a.m. hour. On Waverly Road north of US 56, in 2015 two trucks are projected during this a.m. peak hour. No IMF trucks are projected to use US 56 just west of Waverly and seven trucks are projected on US 56 east of Waverly road during the a.m. peak hour.

3.2.11 Construction Traffic

Construction of the Proposed Action including related infrastructure is currently anticipated to occur over a period of 18 to 22 months. Major road and bridge construction would potentially be completed in the first 12 months. Construction staging areas would mainly be on-site, though some off-site areas may be used related to roadway and bridge construction.

Construction of the roads and bridges could necessitate short-term full and partial road closures; however, access to all homes and properties along the affected roadways would be maintained during construction, thereby limiting impacts to local residents and property owners.

The primary expected types of construction include construction employee traffic, equipment/supply traffic, and material hauling traffic. However, it is not currently known how much construction traffic in each category would be generated by the Proposed Action. There would be many different contractors involved in the project and the extent, approach, and schedule of work for each type of contractor is not known. However, as part of the development of construction phasing and implementation plans, a traffic management plan would be developed in conjunction with the City of Gardner, the City of Edgerton, and Johnson County.

The traffic management plan would also address the routes to be used for construction traffic entering and exiting the site. There are a number of possible major routes for construction traffic traveling to and from the site. As part of the plan development, the various routes would be considered and the preferred routes for each phase of the project would be developed. These phased plans will address topics such as temporary and permanent road closures as well as the construction of the upgraded roadways of 191st Street and Waverly Road. For example, once 191st Street is complete and open to traffic it may become a major route for construction traffic to the site. The construction planning could account for the origins and destinations of materials and equipment on the site as well as the maintenance of adequate emergency access to all parts of the site during construction.

3.3 Indirect Effects - Future Gardner IMF Operations plus Induced Development

This section presents the indirect effects analysis of the proposed Gardner IMF. The reasonably foreseeable indirect effects considered are 2.86 million square feet of warehouse development by TAG-KC of a logistics park, known as the Logistics Park Kansas City. The Logistics Park Kansas City (Crandall VS, 2008) will consist of freight distribution and warehouse facilities. Trip generation and distribution assumptions for the Logistics Park-generated trucks were based on published research, regional commodity flow data, and the aforementioned agency consensus process. The trip generation and distribution assumptions for the Logistics Park are documented in more detail in Appendix A. Detailed operational analysis results are included in Appendix F.

3.3.1 2010 Gardner IMF Operations plus Induced Development

<u>2010 Gardner IMF Operations plus Induced Development Forecast Volumes</u>

The traffic generated by the Proposed Action is discussed in Section 3.1.2. With an opening-day annual lift count of approximately 375,000 to 415,000 (Brian Decker Verified Statement [Decker VS], 2008), it is estimated that the Gardner IMF would generate approximately 2,900 vpd in 2010, including 273 during the a.m. peak hour and 185 during the p.m. peak hour (Table 3-18). As previously described, the table separately identifies bobtails (unloaded trucks with no chassis). Additionally, the table includes trip generation from the Logistics Park Kansas City, which is expected to occupy between 400,000 and 600,000 square feet on opening day and generate approximately 2,300 vpd, including 111 during the a.m. peak hour and 185 during the p.m. peak hour. More detailed information on trip generation is provided in Appendix A.

Table 3-18: 2010 Gardner IMF Operations Plus Induced Development Trip Generation

		AM Peak Hour			PM Peak Hour		
	Daily	in	out	total	in	out	total
IMF							
Trucks	1,489	32	49	81	57	45	102
Bobtails	1,065	23	35	58	41	32	73
Non-Trucks	343	67	67	134	4	6	10
Total	2,897	122	151	273	102	83	185
Logistics Park							
Trucks	473	6	8	14	9	7	16
Non-Trucks	1,842	89	8	97	60	74	134
Total	2,315	95	16	111	69	81	150
IMF + Logistics Park							
Trucks	1,962	38	57	95	66	52	118
Bobtails	1,065	23	35	58	41	32	73
Non-Trucks	2,185	156	75	231	64	80	144
Total	5,212	217	167	384	171	164	335

The 2010 Gardner IMF Operations plus Induced Development ADT and peak-hour forecasts are presented in Figures 3-19 and 3-20 and the peak hour truck percentages are illustrated in Appendix C.

<u>2010 Gardner IMF Operations plus Induced Development Geometry Assumptions</u>

The base geometric assumptions for this scenario are identical to those assumed for the 2010 Gardner Improved No Action scenario.

Figure 3-19: 2010 Gardner IMF Operations plus Induced Development ADTs

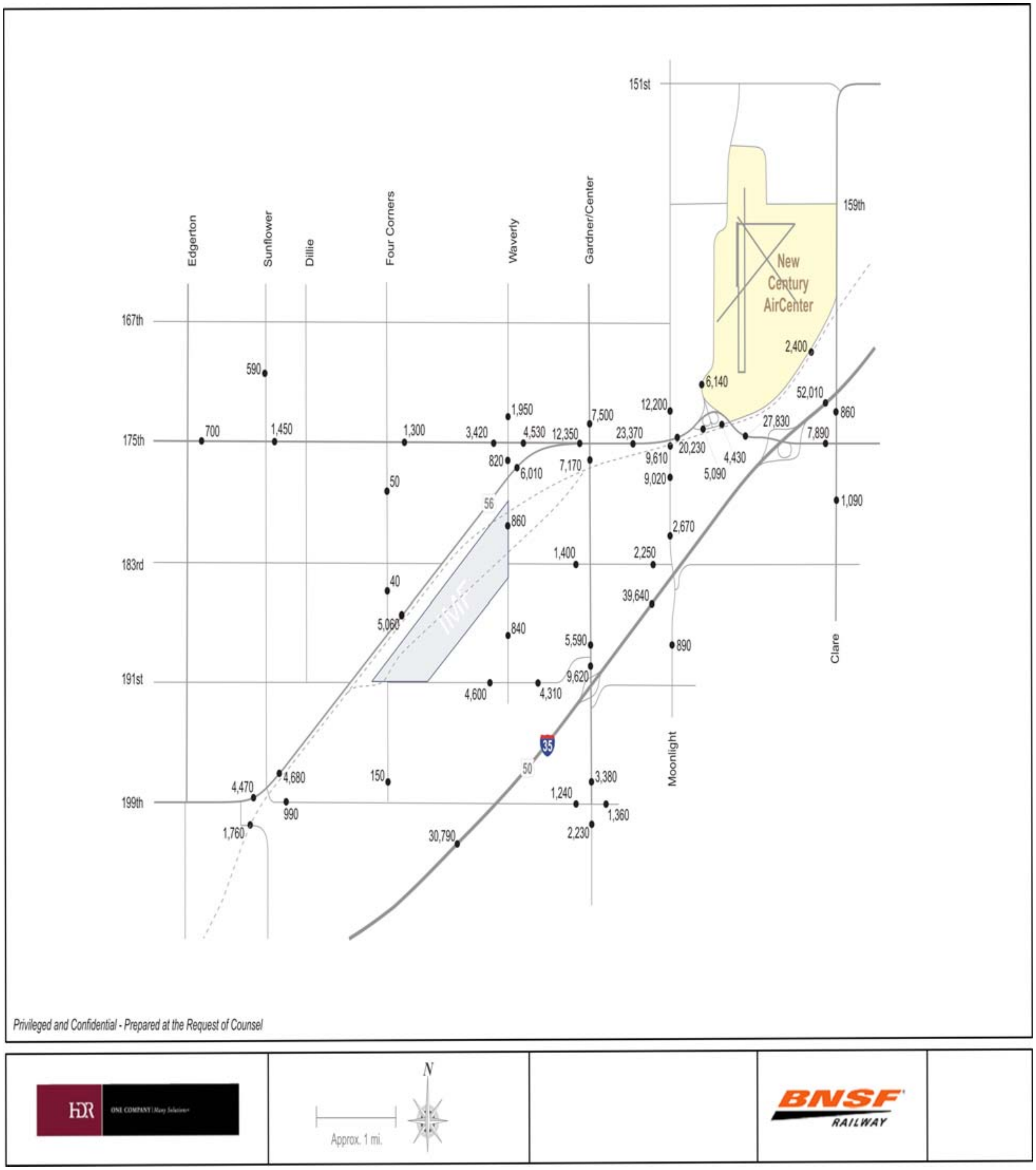
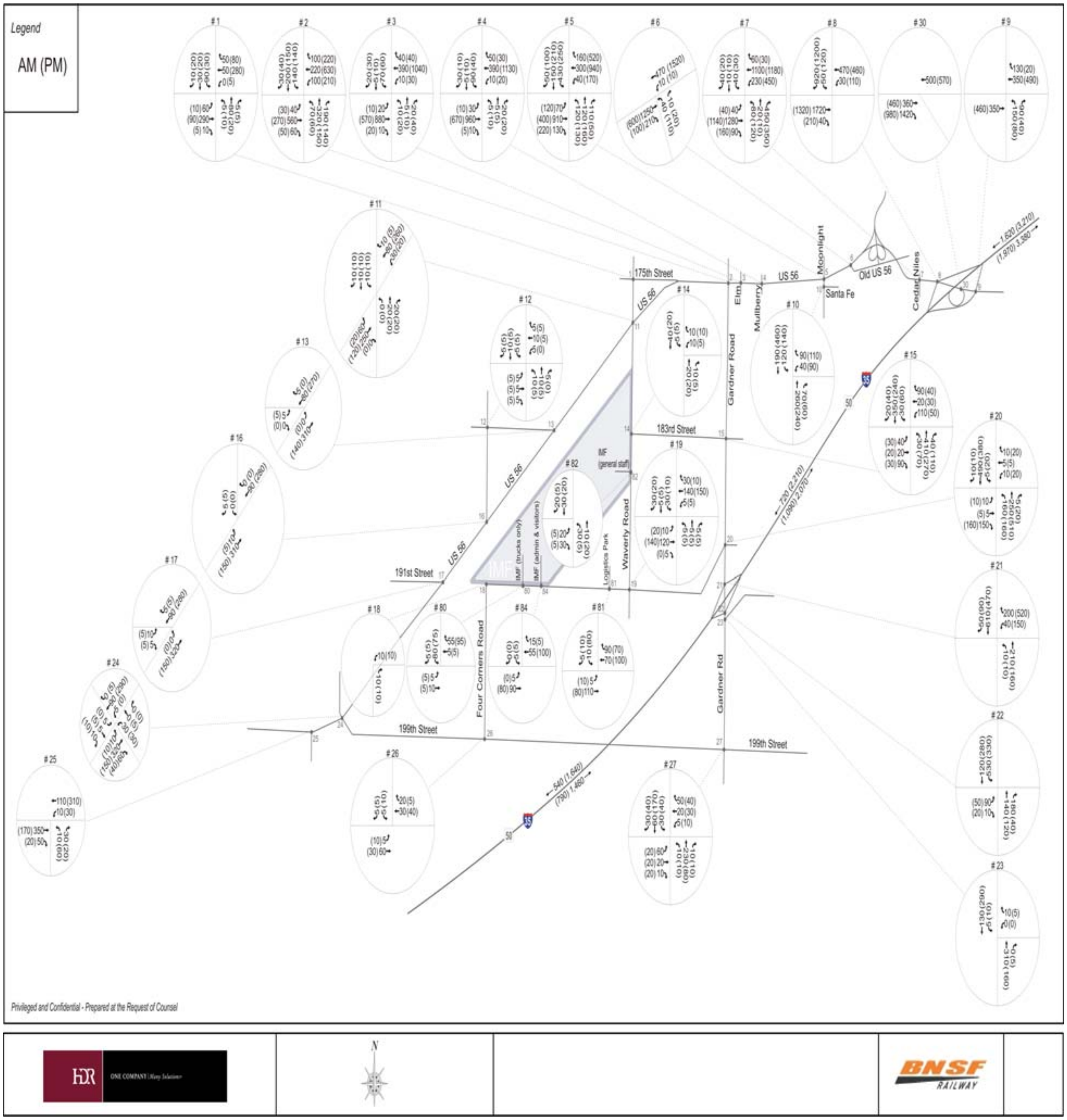


Figure 3-20: 2010 Gardner IMF Operations plus Induced Development Turning Movement Volumes



<u>2010 Gardner IMF Operations plus Induced Development Intersection Analysis</u>

Table 3-19 summarizes the results of this scenario, and provides a comparison to the 2010 No Action and 2010 Proposed Action scenarios. As the table indicates, all study intersections are projected to continue to operate at LOS D or better under this scenario. Therefore, there would be only minor impacts to intersections as a result of the Proposed Action plus induced development in the first year of operations.

Table 3-19: 2010 Gardner IMF Operations plus Induced Development Study Intersection Analysis

			No Action Analysis				**Proposed Action Analysis**				**Gardner IMF Operations + Induced Development Analysis**			
			AM Peak Hr		**PM Peak Hr**		**AM Peak Hr**		**PM Peak Hr**		**AM Peak Hr**		**PM Peak Hr**	
	Location	**Traffic Control**	**Delay (sec/veh)**	**LOS**	**Delay**	**LOS**	**Delay**	**LOS**	**Delay**	**LOS**	**Delay**	**LOS**	**Delay**	**LOS**
1	175th St/ Waverly Rd	TWSC	24.4 (SB)	C	14.2 (SB)	B	25.0 (SB)	D	14.2 (SB)	B	25.2 (SB)	D	14.2 (SB)	B
2	US 56/ Gardner Rd	Sig	17.5	B	17.3	B	21.0	C	17.5	B	18.2	B	17.6	B
3	US 56/ Elm St	Sig	4.8	A	5.7	A	5.5	A	5.7	A	4.8	A	5.7	A
4	US 56/ Mulberry St	Sig	5.7	A	4.0	A	6.0	A	4.1	A	5.8	A	4.1	A
5	US 56/ Moonlight Rd	Sig	23.2	C	16.4	B	22.9	C	16.6	B	24.4	C	31.4	C
6	US 56/ Old US 56	Sig	9.4	A	6.4	A	10.7	B	6.3	A	10.8	B	9.2	A
7	US 56/ Cedar Niles	Sig	19.5	B	19.8	B	15.4	B	20.4	C	18.4	B	20.9	C
8	I-35 SB Ramps/ US 56	Sig	12.8	B	9.7	A	13.7	B	20.2	C	15.3	B	19.8	B
9	I-35 NB Ramps/ US 56	Sig	9.6	A	7.0	A	13.3	B	6.3	A	13.4	B	6.5	A
10	Moonlight Rd/ Santa Fe	Sig	8.0	A	7.4	A	7.9	A	7.5	A	7.9	A	8.2	A
11	US 56/ Waverly Rd	TWSC	14.7 (NB)	B	12.8 (SB)	B	13.9 (NB)	B	13.1 (SB)	B	14.5 (SB)	B	14.0 (SB)	B
12	183rd St/ Four Corners	AWSC	7.0	A	6.9	A	7.0	A	6.9	A	7.0	A	6.9	A
13	183rd St/ US 56	TWSC	12.8 (WB)	B	13.3 (WB)	B	11.8 (EB)	B	11.2 (EB)	B	11.8 (EB)	B	12.0 (EB)	B
14	183rd St/ Waverly Rd	TWSC	9.1 (SB)	A	8.9 (NB)	A	8.7 (WB)	A	8.5 (WB)	A	8.7 (WB)	A	8.6 (WB)	A
15	183rd St/ Gardner Rd	Sig	6.9	A	5.6	A	7.0	A	5.6	A	7.0	A	5.6	A
16	US 56/ Four Corners	TWSC	12.4 (NB)	B	12.6 (NB)	B	8.9 (SB)	A	10.3 (SB)	B	8.9 (SB)	A	10.3 (SB)	B
17	191st St/ US 56	TWSC	12.7 (EB)	B	13.5 (WB)	B	11.2 (EB)	B	11.5 (EB)	B	11.2 (EB)	B	11.4 (EB)	B
18	191st St/ Four Corners	TWSC	8.6 (WB)	A	8.6 (WB)	A								
19	191st St/ Waverly Rd	TWSC	9.0 (NB)	A	8.9 (NB)	A	10.4 (SB)	B	10.1 (SB)	B	10.8 (SB)	B	10.9 (NB)	B
20	Gardner Rd/ 188th St	Sig	3.6	A	4.3	A	8.1	A	6.2	A	7.7	A	8.5	A
21	I-35 SB / Gardner Rd	Sig	6.0	A	13.5	B	9.5	A	15.0	B	10.2	B	18	B
22	I-35 NB / Gardner Rd	Sig	9.3	A	5.2	A	21.0	C	6.8	A	25.4	C	8.6	A
23	Gardner Rd/ E 191st St	OWSC	10.1 (WB)	B	9.3 (WB)	A	10.1 (WB)	B	9.3 (WB)	A	10.1 (WB)	B	9.4 (WB)	A
24	US 56/ Sunflower Rd	TWSC	15.2 (NW)	C	15.5 (NW)	C	15.5 (NW)	C	15.9 (NW)	C	15.5 (NW)	C	15.9 (NW)	C
25	US 56/ E 4th St	OWSC	12.5 (NB)	B	15.4 (NB)	C	12.5 (NB)	B	15.4 (NB)	C	12.5 (NB)	B	15.4 (NB)	C
26	199th St/ Four Corners	OWSC	9.2 (SB)	A	8.9 (SB)	A	9.2 (SB)	A	9.1 (SB)	A	9.2 (SB)	A	9.2 (SB)	A
27	199th St/ Gardner Rd	AWSC	9.3	A	8.9	A	9.3	A	8.9	A	9.3	B	9.0	A
80	IMF (Truck Entr)	OWSC	--	--	--	--	10.4 (SB)	B	10.5 (SB)	B	10.6 (SB)	B	10.5 (SB)	B
81	Logistic Park	OWSC	--	--	--	--					10.9 (SB)	B	10.7 (SB)	B
82	IMF (Gen Staff Entr)	OWSC	--	--	--	--	9.2 (EB)	A	8.7 (EB)	A	9.3 (EB)	A	8.8 (EB)	A
84	IMF (Admin Entr)	OWSC	--	--	--	--	9.3 (SB)	A	9.5 (SB)	A	9.6 (SB)	A	9.6 (SB)	A

Notes: TWSC – Two-way STOP control, OWSC – One-way STOP control, AWSC – All-way STOP control, LOS – Level of Service.
For one and two-way STOP-controlled intersections the delay and LOS for the worst approach is shown.

<u>2010 Gardner IMF Operations plus Induced Development Freeway/Ramp Analysis</u>

Table 3-20 summarizes the results of the freeway analysis for this scenario. The analysis forecasted that all segments and ramps would operate at LOS D or better. Therefore, there would be only minor impacts to freeway segments or ramps as a result of the Proposed Action plus induced development in the first year of operations.

Table 3-20: 2010 Gardner IMF Operations plus Induced Development Freeway/Ramp Analysis

Location	Lanes	AM Peak Hour Density (pc/mi/ln)	AM Peak Hour LOS	PM Peak Hour Density (pc/mi/ln)	PM Peak Hour LOS
Basic Freeway Segments					
I-35 NB					
Sunflower to Waverly	2	12.1	B	6.8	A
Gardner to US 56	2	17.3	B	9.6	A
US 56 to 151st Street	2	29.3	D	16.6	B
I-35 SB					
151st St to US 56	2	13.6	B	27.8	D
US 56 to Gardner	2	6.3	A	18.7	C
Waverly to Sunflower	2	4.7	A	13.7	B
Ramp Merge/Diverge					
I-35 NB					
Gardner Road Off	N/A	11.6	B	5.3	A
Gardner Road On	N/A	19.6	B	11.4	B
US 56 Off	N/A	17.8	B	8.6	A
US 56 EB on-loop	N/A	30.9	D	20.0	B
US 56 WB on	N/A	29.9	D	18.0	B
I-35 SB					
US 56 Off	N/A	13.4	B	29.1	D
US 56 On	N/A	7.1	A	20.3	C
Gardner Road Off	N/A	4.7	A	19.5	B
Gardner Road On	N/A	5.6	A	15.6	B

Notes: pc/mi/ln – passenger cars per mile per lane, LOS – Level of Service.

3.3.2 2015 Gardner IMF Operations plus Induced Development

<u>2015 Gardner IMF Operations plus Induced Development Forecast Volumes</u>

Under this scenario, the Gardner IMF is projected to operate with 495,000 annual lifts and generate nearly 3,500 vpd, including 335 during the a.m. peak hour and 222 during the p.m. peak hour. The Logistics Park Kansas City is expected to occupy 2.86 million square feet and generate approximately 11,000 vpd, including 530 during the a.m. peak hour and 716 during the p.m. peak hour (Table 3-21).

These trips were assigned to the traffic study area roadways using procedures described earlier in this document and detailed in Appendix A.

The 2015 Gardner IMF Operations plus Induced Development scenario ADT and peak-hour forecasts are presented in Figures 3-21 and 3-22. Peak hour truck percentages are illustrated in Appendix C.

Table 3-21: 2015 Gardner IMF Operations plus Induced Development Trip Generation

	Daily	AM Peak Hour in	AM Peak Hour out	AM Peak Hour total	PM Peak Hour in	PM Peak Hour out	PM Peak Hour total
IMF							
Trucks	1,776	39	58	97	68	54	122
Bobtails	1,270	28	42	70	49	38	87
Non-Trucks	430	84	84	168	5	8	13
Total	3,476	151	184	335	122	100	222
Logistics Park							
Trucks	2,254	31	38	69	42	34	76
Non-Trucks	8,781	423	38	461	287	353	640
Total	11,035	454	76	530	329	387	716
IMF+ Logistics Park							
Trucks	4,030	70	96	166	110	88	198
Bobtails	1,270	28	42	70	49	38	87
Non-Trucks	9,211	507	122	629	292	361	653
Total	14,511	605	260	865	451	487	938

Note: Bobtails are not typically measured at existing IMFs.
A conservative estimate was calculated to capture potential bobtail traffic. Actual bobtail trips are likely to be less than what has been projected as trips will be generated by lifts and container staging.

<u>2015 Gardner IMF Operations plus Induced Development Geometry Assumptions</u>

The base geometry assumptions for this scenario are identical to those of the 2015 Gardner No Action scenario.

Figure 3-21: 2015 Gardner IMF Operations plus Induced Development ADTs

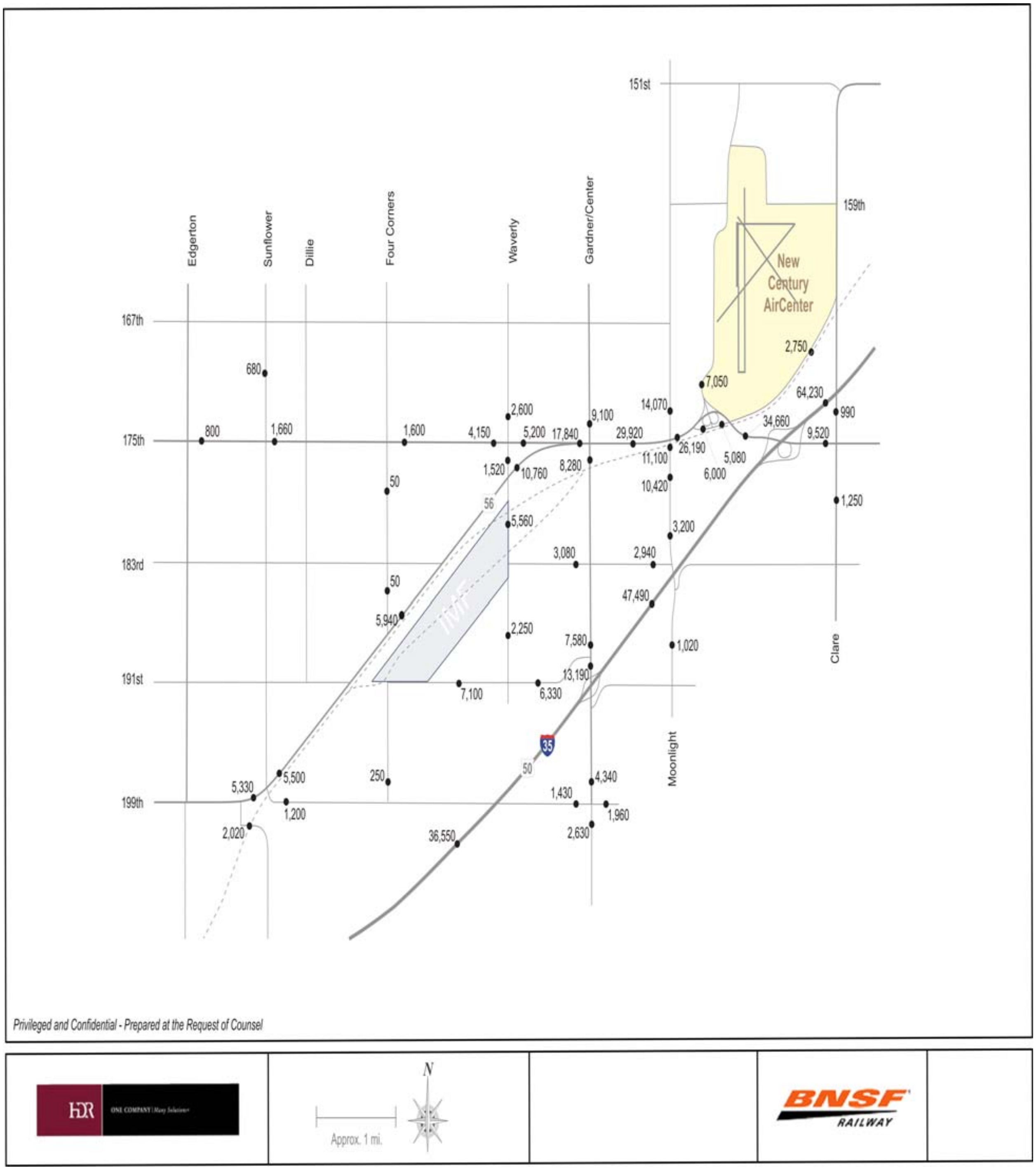
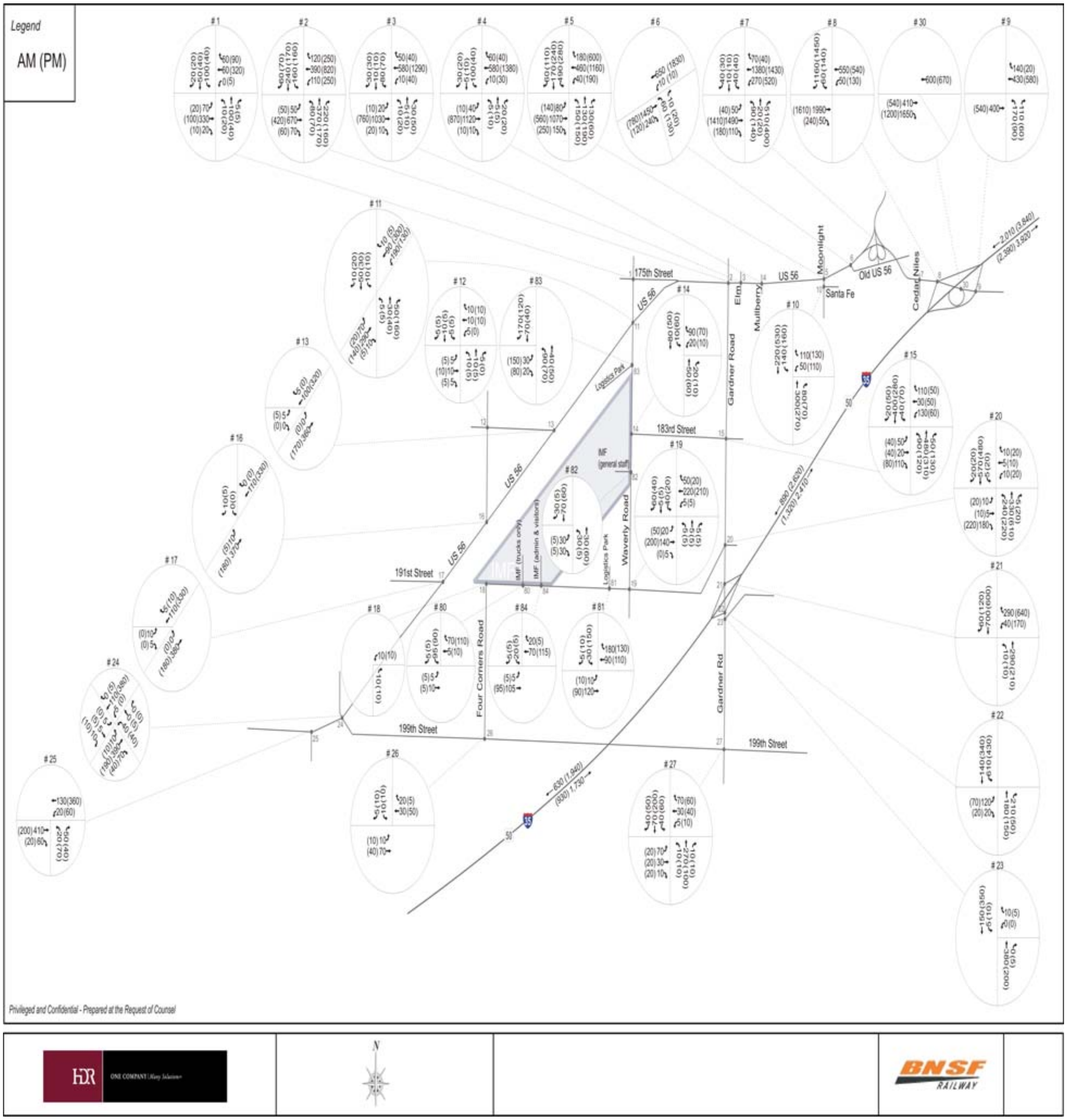


Figure 3-22: 2015 Gardner IMF Operations plus Induced Development Turning Movement Volumes



2015 Gardner IMF Operations plus Induced Development Intersection Analysis

The results of the intersection analysis for this scenario are shown in Table 3-22. The 2015 analysis forecasted that two study intersections would operate at LOS E or worse during the a.m. peak hour as a result of induced development. The intersections evaluated, and their forecasted operations under the No Action and 2015 Gardner IMF operations plus induced development scenarios are described below and highlighted in Table 3-22:

- *Intersection #11 (US 56/Waverly Road):* The southbound approach to this intersection is projected to operate at LOS F during the a.m. peak hour.
- *Intersection #22 (I-35 Northbound Ramps/Gardner Road):* This intersection is projected to operate at LOS E during the a.m. peak hour.

The indirect impact associated with Intersection #11 is considered to be significant, and potential mitigation measures are discussed in the *Mitigation Technical Report* (HDR 2008c). While Intersection #22 is predicted to operate below the acceptable LOS threshold in 2015, based on coordination with KDOT, the impact is not considered to be significant because the condition is predicted to be temporary and will be alleviated by the opening of the I-35/Waverly Road interchange by the end of 2015 or shortly thereafter.

Table 3-22: Comparison of 2015 Gardner No Action, IMF Operations, and Induced Development Study Intersection Analysis

		No Action				Gardner IMF Operations				Gardner IMF Operations + Induced Development			
		AM Peak hr		PM Peak hr		AM Peak hr		PM Peak hr		AM Peak hr		PM Peak hr	
Location	Traffic Control	Delay (sec/veh)	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
1 175th St/ Waverly Rd	AWSC	15.1	C	12.3	B	15.5	C	12.4	B	16.8	C	13.2	B
2 US 56/ Gardner Rd	Sig	24.9	C	27.1	C	26.1	C	27.8	C	34.9	C	49.4	D
3 US 56/ Elm St	Sig	4.5	A	3.8	A	4.7	A	3.9	A	4.7	A	4.9	A
4 US 56/ Mulberry St	Sig	5.4	A	3.8	A	5.7	A	3.7	A	6.4	A	4.3	A
5 US 56/ Moonlight Rd	Sig	27.6	C	24.8	C	28.4	C	22.7	C	26.4	C	23.9	C
6 US 56/ Old US 56	Sig	9.9	A	9.2	A	11.1	B	9.5	A	10.4	B	10.8	B
7 US 56/ Cedar Niles	Sig	19	B	21.5	C	15.7	B	21.4	C	19	B	24.4	C
8 I-35 SB Ramps/ US 56	Sig	13.5	B	16.7	B	16.4	B	34.8	C	21.8	C	36.2	D
9 I-35 NB Ramps/ US 56	Sig	12.2	B	7	A	14.7	B	8.3	A	14.4	B	11.1	B
10 Moonlight Rd/ Santa Fe	Sig	8.4	A	8.6	A	8.2	A	8.1	A	7.5	A	9.6	A
11 US 56/ Waverly Rd	TWSC	16.1 (NB)	C	13.0 (SB)	B	16.2 (NB)	C	13.8 (SB)	B	58.6 (SB)	F	29.9 (SB)	D
12 183rd St/ Four Corners	AWSC	7.0	A	6.9	A	7.0	A	6.9	A	7.0	A	6.9)	A
13 183rd St/ US 56	TWSC[1]	14.2 (EB)	B	14.5 (WB)	B	12.7 (EB)	B	12.8 (EB)	B	12.7 (EB)	B	13.0 (EB)	B
14 183rd St/ Waverly Rd	TWSC[1]	9.2 (SB)	A	9.0 (NB)	A	8.9 (WB)	A	8.5 (WB)	A	9.3 (WB)	A	9.2 (WB)	A
15 183rd St/ Gardner Rd	Sig	19.1	B	15	B	13.2	B	8.8	A	19.6	B	12.3	B
16 US 56/ Four Corners	TWSC[1]	13.3 (NB)	B	13.8 (NB)	B	9.0 (SB)	A	10.7 (SB)	B	9.0 (EB)	A	10.8 (EB)	B
17 191st St/ US 56	TWSC[1]	13.7 (EB)	B	14.5 (WB)	B	11.9 (EB)	B	12.2 (EB)	B	12.0 (EB)	B	12.4 (EB)	B
18 191st St/ Four Corners	TWSC	8.6 (WB)	A	8.6 (WB)	A	--	--	--	--	--	--	--	--
19 191st St/ Waverly Rd	TWSC	9.0 (NB)	A	8.9 (NB)	A	10.8 (SB)	B	10.3 (SB)	B	12.6 (SB)	B	13.0 (NB)	B
20 Gardner Rd/ 188th St	Sig	3.7	A	4.0	A	11.3	B	5.7	A	9.3	A	9.5	A
21 I-35 SB / Gardner Rd	Sig	5.4	A	12.7	B	12.0	B	13.6	B	14.6	B	17.2	B
22 I-35 NB / Gardner Rd	Sig	15.4	B	6.9	A	53.5	D	9.3	A	76.6	E	17.4	B
23 Gardner Rd/ E 191st St	OWSC	10.4 (WB)	B	9.5 (WB)	A	10.4 (WB)	B	9.5 (WB)	A	10.7 (WB)	B	9.7 (WB)	A
24 US 56/ Sunflower Rd	TWSC	17.2 (NW)	C	18.9 (NW)	C	18.2 (NW)	C	20.0 (NW)	C	18.5 (NW)	C	20.4 (NW)	C
25 US 56/ E 4th St	OWSC	14.6 (NB)	B	19.0 (NB)	C	14.7 (NB)	B	19.3 (NB)	C	14.7 (NB)	B	19.7 (NB)	C
26 199th St/ Four Corners	OWSC	9.3 (SB)	A	9.0 (SB)	A	9.4 (SB)	A	9.3 (SB)	A	9.4 (SB)	A	9.2 (SB)	A
27 199th St/ Gardner Rd	AWSC	9.9	A	9.4	A	10.1	B	9.5	A	10.3	B	10.0	B
80 IMF (Truck Entr)	OWSC	--	--	--	--	10.6 (SB)	B	10.8 (SB)	B	10.6 (SB)	B	10.8 (SB)	B
81 Logistics Park	OWSC	--	--	--	--	--	--	--	--	11.6 (SB)	B	12.2 (SB)	B
82 IMF (Gen Staff Entr)	OWSC	--	--	--	--	9.2 (EB)	A	8.7 (EB)	A	9.8 (EB)	A	9.3 (EB)	A
83 Logistics Park	OWSC	--	--	--	--	--	--	--	--	12.8 (EB)	B	12.7 (EB)	B
84 IMF (Admin Entr)	OWSC	--	--	--	--	9.7 (SB)	A	9.4 (SB)	A	9.6 (SB)	A	9.4 (SB)	A

Notes: TWSC – Two-way STOP control, OWSC – One-way STOP control, AWSC – All-way STOP control, LOS – Level of Service.
Bold indicates a LOS below the acceptable threshold
For one and two-way STOP-controlled intersections the delay and LOS for the worst approach is shown.
[1] In the Proposed Action and Indirect Effects scenarios these intersections become OWSC due to road closures.

2015 Gardner IMF Operations plus Induced Development Freeway/Ramp Analysis

Table 3-23 summarizes the LOS analysis for freeways and ramps. Like the 2015 Gardner IMF Operations scenario, the analysis predicted an LOS E on northbound I-35 from US 56 to 151st Street in 2015 as well as at the associated US 56 eastbound on-loop to northbound I-35. The analysis also predicted levels or service below the desirable threshold in two additional areas:

- *I-35 Southbound, 151st Street to US 56*: This segment is projected to operate at LOS E; it is the reverse/complementary direction of the segment described above.
- *I-35 Southbound Off-Ramp to US 56*: This ramp is forecasted to operate at LOS E.

However, these four capacity issues would be anticipated to be addressed by planned improvements included in the MARC LRTP. Therefore, only minor adverse impacts are predicted to occur to freeway and ramp operation. If for some reason, the planned improvements to I-35 do not follow what is currently outlined in the LRTP, the 2015 traffic volumes would be near the LOS D/E threshold. Only minimal traffic diversion to the local and regional arterial street system in 2015 would be expected.

Table 3-23: 2015 Gardner IMF Operations plus Induced Development Freeway/Ramp Analysis

Location	Lanes	AM Peak Hour Density (pc/mi/ln)	AM Peak Hour LOS	PM Peak Hour Density (pc/mi/ln)	PM Peak Hour LOS
Basic Freeway Segments					
I-35 NB					
Sunflower to Waverly	2	14.3	B	8.1	A
Gardner to US 56	2	20.1	C	11.5	B
US 56 to 151st Street	2	**38.1**	**E**	20.1	C
I-35 SB					
151st St to US 56	2	16.8	B	**37.6**	**E**
US 56 to Gardner	2	7.8	A	22.3	C
Waverly to Sunflower	2	5.5	A	16.2	B
Ramp Merge/Diverge					
I-35 NB					
Gardner Road Off	N/A	14.2	B	6.8	A
Gardner Road On	N/A	22.8	C	13.6	B
US 56 Off	N/A	21.2	C	10.9	B
US 56 EB on-loop	N/A	**35.6**	**E**	23.9	C
US 56 WB on	N/A	34.8	D	22.0	C
I-35 SB					
US 56 Off	N/A	17.3	B	**35.4**	**E**
US 56 On	N/A	8.7	A	24.0	C
Gardner Road Off	N/A	6.5	A	23.7	C
Gardner Road On	N/A	6.5	A	18.4	B

Notes: pc/mi/ln – passenger cars per mile per lane, LOS – Level of Service.
Bold indicates a LOS below the acceptable threshold

3.3.3 2030 Gardner IMF Operations plus Induced Development

2030 Gardner IMF Operations plus Induced Development Forecast Volumes
Under this scenario, the proposed Gardner IMF is projected to operate with 870,000 annual lifts and generate nearly 6,000 vpd, including approximately 563 during the a.m. peak hour and 388 during the p.m. peak hour. Based on reasonably foreseeable growth, the Logistics Park Kansas City is expected to occupy 2.86 million square feet (Crandall VS, 2008) and generate approximately 11,000 vpd, including 530 during the a.m. peak hour, and 716 during the p.m. peak hour (Table 3-24).

These trips were assigned to the study area roadways using procedures described earlier in this document and detailed in Appendix A.

Table 3-24: 2030 Gardner IMF Operations plus Induced Development Trip Generation

		AM Peak Hour			PM Peak Hour		
	Daily	in	out	total	in	out	total
IMF							
Trucks	3,121	68	103	171	120	94	214
Bobtails	2,233	49	73	122	86	67	153
Non-Trucks	691	135	135	270	7	14	21
Total	6,045	252	311	563	213	175	388
Logistics Park							
Trucks	2,254	31	38	69	42	34	76
Non-Trucks	8,781	423	38	461	287	353	640
Total	11,035	454	76	530	329	387	716
IMF + Logistics Park							
Trucks	5,375	99	141	240	162	128	290
Bobtails	2,233	49	73	122	86	67	153
Non-Trucks	9,472	558	173	731	294	367	661
Total	17,080	706	387	1,093	542	562	1,104

Note: Bobtails are not typically measured at existing IMFs. A conservative estimate was calculated to capture potential bobtail traffic. Actual bobtail trips are likely to be less than what has been projected as trips will be generated by

The 2030 Gardner IMF Operations plus Induced Development ADT and peak-hour forecasts are presented in Figures 3-23 and 3-24. Peak hour truck percentages are illustrated in Appendix C.

2030 Gardner IMF Operations plus Induced Development Geometry Assumptions
The base geometry assumptions for this scenario are identical to those of the 2030 Gardner Improved No Action scenario.

Figure 3-23: 2030 Gardner IMF Operations plus Induced Development ADTs

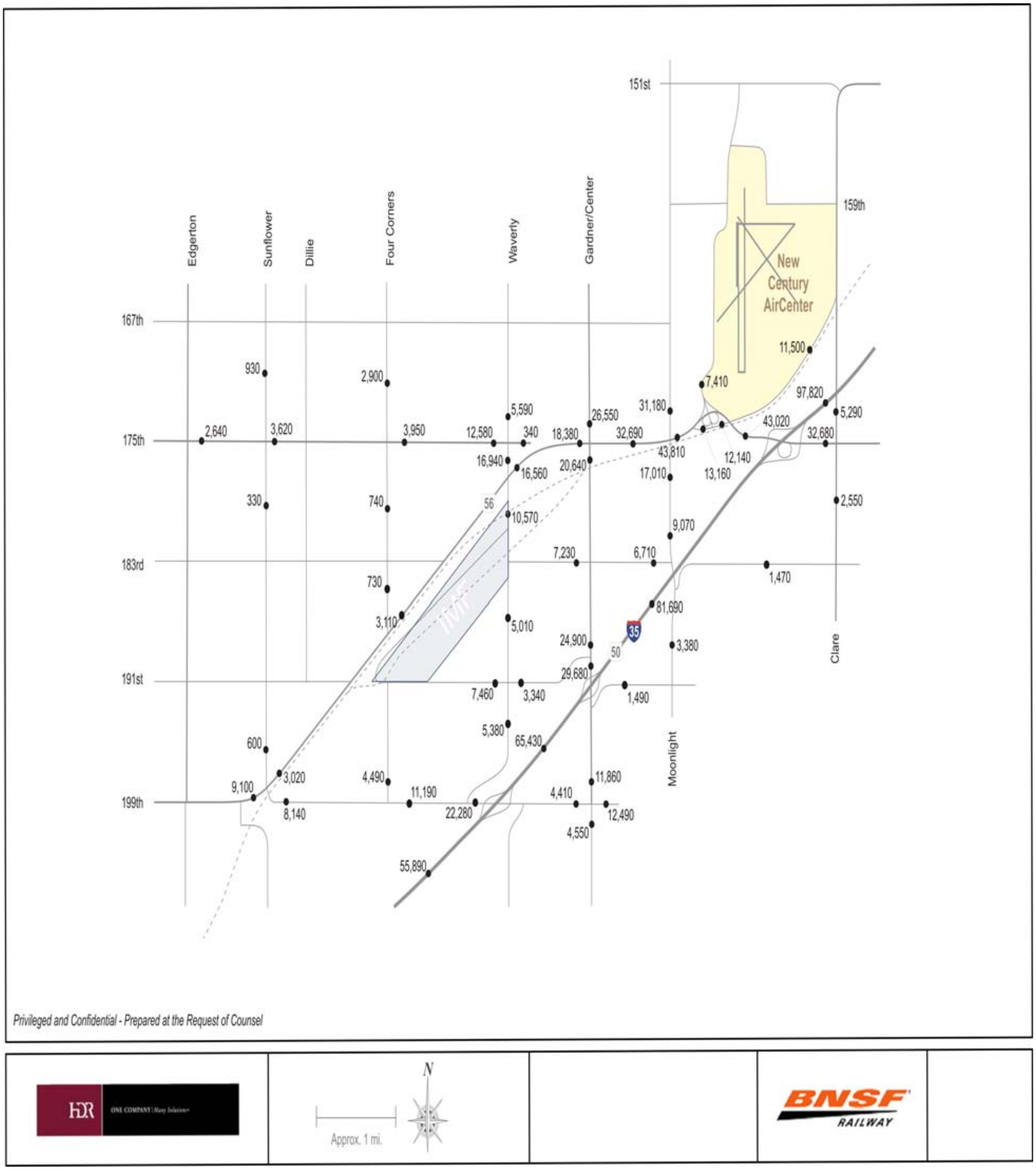
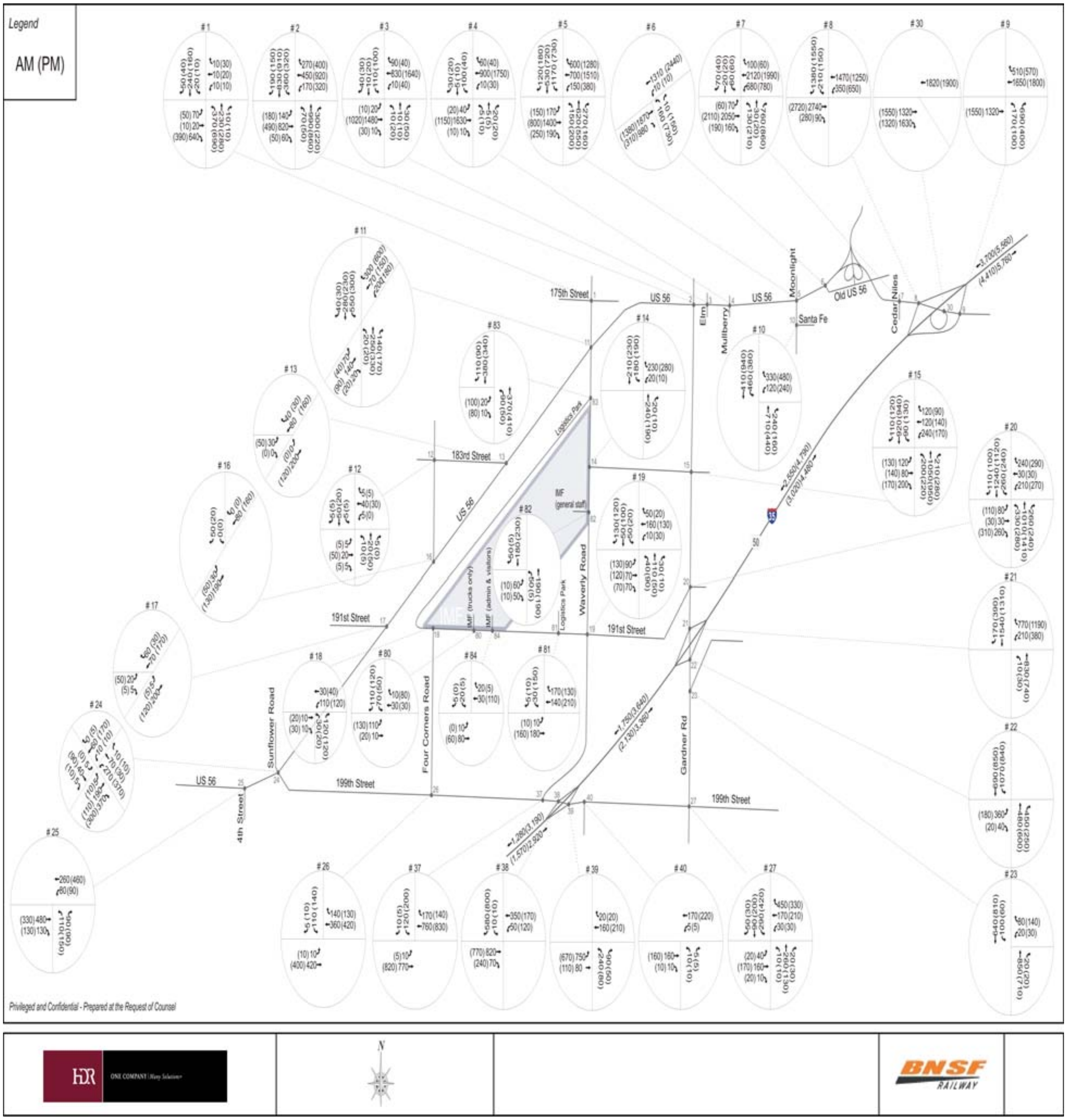


Figure 3-24: 2030 Gardner IMF Operations plus Induced Development Turning Movement Volumes



<u>2030 Gardner IMF Operations plus Induced Development Intersection Analysis</u>

Table 3-25 summarizes the results of the intersection analysis for this scenario. As the table indicates, the three intersections that were projected to operate below the acceptable LOS threshold under the Improved No Action scenario (5, 7, 8) are projected to continue to operate at the same LOS with the addition of the Proposed Action and indirect effects, with generally minor changes in delay that are not considered significant. The two intersections that were projected to operate below the acceptable LOS threshold under the 2030 Gardner IMF Operations scenario (26, 37) are projected to continue to experience levels of service below the acceptable threshold under this scenario; however, this is considered a moderate potential impact in 2030 and mitigation is not required.

In addition, LOS issues are projected at one other intersection:

- *Intersection 19 (191st Street/Waverly Road)*: The northbound approach to the intersection is projected to operate at LOS F during the p.m. peak hour. This year 2030 potential impact is considered moderate and would not require mitigation.

Table 3-25: 2030 Gardner IMF Operations plus Induced Development Study Intersection Analysis

		Improved No Action				Proposed Action				Indirect Effects			
		AM Peak Hr		PM Peak Hr		AM Peak hr		PM Peak Hr		AM Peak hr		PM Peak Hr	
Location	Traffic Control	Delay (sec/veh)	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
1 175th St/ Waverly Rd	Sig	19.0	B	15.4	B	20.6	C	15.8	B	21.4	C	15.5	B
2 US 56/ Gardner Rd	Sig	29.1	C	27.2	C	31.0	C	31.8	C	30.2	C	34.7	C
3 US 56/ Elm St	Sig	6.7	A	8.2	A	6.9	A	8.2	A	6.8	A	8.3	A
4 US 56/ Mulberry St	Sig	5.6	A	4.4	A	5.6	A	4.6	A	5.8	A	4.8	A
5 US 56/ Moonlight Rd	Sig	**105.9**	F	**111.4**	F	**107.8**	F	**121.4**	F	**106.5**	F	**119.7**	F
6 US 56/ Old US 56	Sig	13.7	B	24.9	C	14.6	B	28.3	C	15.2	B	23.3	C
7 US 56/ Cedar Niles	Sig	36.7	D	**60.4**	E	37.7	D	**60.9**	E	38.7	D	**60.0**	E
8 I-35 SB Ramps/ US 56	Sig	**119.3**	F	**184.3**	F	**116**	F	**185.4**	F	**118**	F	**187.8**	F
9 I-35 NB Ramps/ US 56	Sig	21	C	12.5	B	20.4	C	12.7	B	20.3	C	12.8	B
10 Moonlight Rd/ Santa Fe	Sig	22.1	C	19.3	B	22.7	C	19.9	B	22	C	22.2	C
11 US 56/ Waverly Rd	Sig	25.8	C	34.0	C	27.5	C	36.7	D	27.6	C	35.0	C
12 183rd St/ Four Corners	AWSC	8.4	A	8.6	A	7.4	A	7.4	A	7.4	A	7.4	A
13 183rd St/ US 56	TWSC	12.4 (WB)	B	13.4 (EB)	B	10.5 (EB)	B	10.7 (EB)	B	10.5 (EB)	B	10.7 (EB)	B
14 183rd St/ Waverly Rd	TWSC	12.0 (NB)	B	13.0 (SB)	B	12.6 (WB)	B	11.2 (WB)	B	13.5 (WB)	B	12.4 (WB)	B
15 183rd St/ Gardner Rd	Sig	24.6	C	18.9	B	25.7	C	30.5	C	25.6	C	33.5	C
16 US 56/ Four Corners	TWSC	15.8 (SB)	C	18.2 (NB)	C	8.9 (SB)	A	9.2 (SB)	A	8.9 (SB)	A	9.2 (SB)	A
17 191st St/ US 56	TWSC	11.0 (EB)	B	11.4 (EB)	B	10.2 (EB)	B	10.8 (EB)	B	10.2 (EB)	B	10.8 (EB)	B
18 191st St/ Four Corners	OWSC	10.3 (WB)	B	10.0 (WB)	B	Does not exist		Does not exist		10.7 (NB)	B	10.9 (NB)	B
19 191st St/ Waverly Rd	TWSC	10.0 (SB)	A	10.8 (SB)	B	14.9 (SB)	B	22.8 (NB)	C	22.8 (NB)	C	**107.2(NB)**	F
20 Gardner Rd/ 188th St	Sig	24.3	C	37.6	D	25.9	C	37.9	D	28.4	C	35.9	D
21 I-35 SB / Gardner Rd	Sig	13.1	B	24.3	C	12.9	B	25.3	C	13.7	B	23.5	C
22 I-35 NB / Gardner Rd	Sig	39.9	D	21.1	C	42.4	D	28.0	C	39.0	D	27.3	C
23 Gardner Rd/ E 191st St	Sig	6.3	A	9.5	A	6.5	A	9.6	A	6.8	A	9.3	A
24 US 56/ Sunflower Rd	Sig	19.0	B	19.3	B	18.7	B	27.1	C	20.1	C	31.1	C
25 US 56/ E 4th St	Sig	10.9	B	11.7	B	11.2	B	12.3	B	11.2	B	12.2	B
26 199th St/ Four Corners	OWSC	20.0 (SB)	C	20.8 (SB)	C	**44.5 (SB)**	E	**51.7 (SB)**	F	**42.6 (SB)**	E	**57.4 (SB)**	F
27 199th St/ Gardner Rd	Sig	27.0	C	21.7	C	27.0	C	23.2	C	27.4	C	23.4	C
37 199th St/Waverly Rd	OWSC	16.9 (SB)	C	21.1 (SB)	C	32.5 (SB)	D	**47.6 (SW)**	E	**41.5 (SW)**	E	**76.8 (SW)**	F
38 199th St/I-35 SB	Sig	16.5	B	21.1	C	22.6	C	48.4	D	31.0	C	43.7	D
39 199th St/I-35 NB	Sig	14.0	B	7.7	A	22.7	C	9.5	A	27.9	C	19.9	B
40 199th St/Waverly Rd	OWSC	10.6 (NB)	B	11.1 (NB)	B	10.2 (NB)	B	10.5 (NB)	B	10.3 (NB)	B	10.6 (NB)	B
80 IMF (Truck Entr)	--	--	--	--	--	13.5(SB)	B	14.4(SB)	B	13.9(SB)	B	15.3(SB)	C
81 Logistics Park	--	--	--	--	--	--	--	--	--	12.8(SB)	B	15.0(SB)	C
82 IMF (Gen Staff Entr)	--	--	--	--	--	13.3(EB)	B	10.9(EB)	B	13.5(EB)	B	11.6(EB)	B
83 Logistics Park	--	--	--	--	--	--	--	--	--	24.5(EB)	C	21.6(EB)	C
84 IMF (Admin Entr)	--	--	--	--	--	9.2(SB)	A	9.0(SB)	A	9.3(SB)	A	9.5(SB)	A

Notes: TWSC – Two-way STOP control, OWSC – One-way STOP control, AWSC – All-way STOP control, LOS – Level of Service.
Bold indicates a LOS below the acceptable threshold.
For one and two-way STOP-controlled intersections the delay and LOS for the worst approach is shown.

2030 Gardner IMF Operations plus Induced Development Freeway/Ramp Analysis

Table 3-26 summarizes the LOS analysis for freeways and ramps. Like the 2030 Gardner IMF Operations scenario, the analysis predicted LOS E on northbound I-35 from US 56 to 151st Street, and the associated US 56 eastbound on-loop to northbound I-35. However, this scenario also shows a LOS below the acceptable threshold in one additional area:

- *I-35 Southbound, 151st Street to US 56*: This segment is projected to operate at LOS E (just exceeding the D/E threshold); it is the reverse/complementary direction of the segment previously described. It is fairly typical to widen freeway basic lanes symmetrically; thus, it would be reasonable to expect that in addressing the improvements needed in the 2030 No Action scenario (southbound), the northbound segment would also be widened. Therefore, it is not considered a significant impact

No capacity improvements for this area are currently programmed in the LRTP. However, because this area would fail under the No Action scenario, these LOS issues are not considered to be significant impacts from the Gardner IMF or Induced Development.

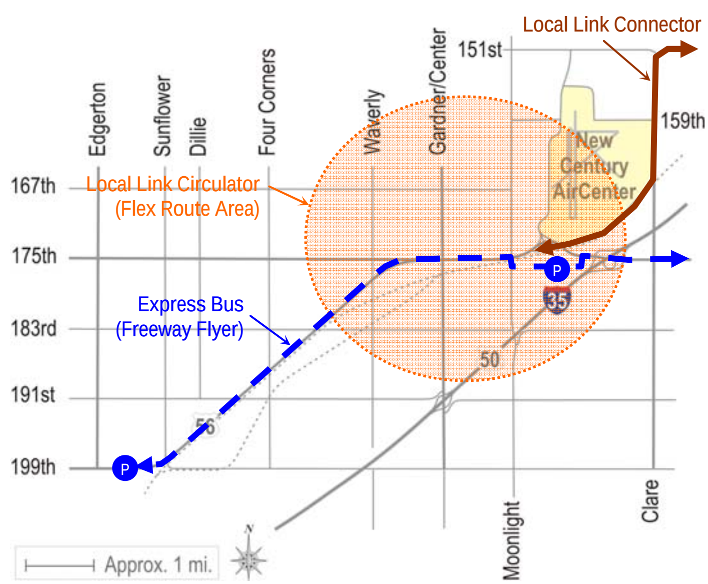
Table 3-26: 2030 Gardner IMF Operations plus Induced Development Freeway/Ramp Analysis

Location	Lanes	AM Peak Hour Density (pc/mi/ln)	AM Peak Hour LOS	PM Peak Hour Density (pc/mi/ln)	PM Peak Hour LOS
Basic Freeway Segments					
I-35 NB					
Sunflower to Waverly	2	24.5	C	13.7	B
Waverly to Gardner	3	18.8	C	12.5	B
Gardner to US 56	3	25.3	C	17.3	B
US 56 to 151st Street	3	**37.3**	**E**	25.3	C
I-35 SB					
151st St to US 56	3	20.8	C	**35.7**	**E**
US 56 to Gardner	3	14.6	B	28.1	D
Gardner to Waverly	3	10.2	A	20.7	C
Waverly to Sunflower	2	11.1	B	27.9	D
Ramp Merge/Diverge					
I-35 NB					
Waverly Road Off	N/A	26.1	C	13.6	B
Waverly Road On	N/A	22.8	C	16.3	B
Gardner Road Off	N/A	20.2	C	13.1	B
Gardner Road On	N/A	29.5	D	21.0	C
US 56 Off	N/A	26.8	C	18.9	B
US 56 EB on-loop	N/A	**35.4**	**E**	27.7	C
US 56 WB on	N/A	32.3	D	25.9	C
I-35 SB					
US 56 Off	N/A	10.9	B	19.9	B
US 56 On	N/A	15.9	B	29.6	D
Gardner Road Off	N/A	17.1	B	30.4	D
Gardner Road On	N/A	10.8	B	21.8	C
Waverly Road Off	N/A	11.7	B	23.6	C
Waverly Road On	N/A	12.6	B	29.9	D

Notes: pc/mi/ln – passenger cars per mile per lane, LOS – Level of Service.
Bold indicates a LOS below the acceptable threshold.

3.3.4 Transit

Figure 3-25: Long-Term Planned Transit Service



With the addition of the 2.86 million square feet of warehousing associated with the Logistics Park Kansas City by 2015, it is expected that the demand for transit would increase somewhat over the Gardner IMF Operations Scenario. It is estimated that this new warehouse development would employ over 1,700 people. However, given the low-density development patterns required for modern warehouse space, and the two- and three-shift patterns often in use in these facilities, it may still be difficult to effectively and efficiently serve this development with transit. While transit service to the development could be pursued in the future as the development proceeded, it might not be practical in the near-term. However, given the proposal for a Gardner circulator bus route (Figure 3-25), it would be beneficial if planning for that route would consider any new Logistics Park Kansas City warehousing space. This planned circulator route presents a good opportunity for providing enhanced transportation options in the Gardner area. It may also be beneficial if Johnson County Transit considered providing reverse-commute transit service as part of its peak-period express service to the Gardner area (a.m. inbound to Gardner and p.m. outbound from Gardner). This could potentially be implemented with modest added cost and could increase accessibility for employees living in other parts of the metro area. However, neither of these planning considerations for transit is considered necessary as a consequence of development of the Logistics Park Kansas City.

3.3.5 Pedestrian/Bicycle

With the addition of the Logistics Park Kansas City, two potential areas of impact were considered: the potential pedestrian, bicycle, and trail activity or demand associated with the Logistics Park Kansas City development and the physical relationship of this development to existing and proposed pedestrian, bicycle, and trail facilities.

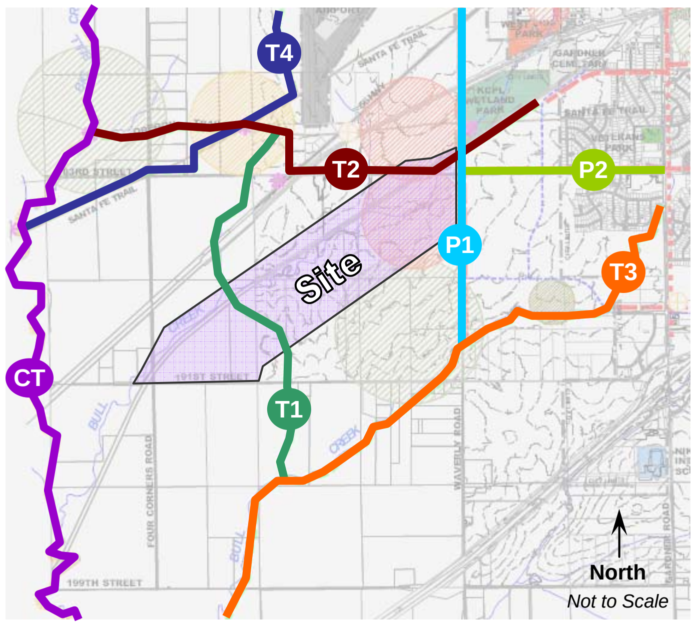
On opening day (2010), off-site pedestrian traffic associated with the Logistics Park Kansas City development is expected to be minimal. The primary reason for this is the long walk distances between the development and most residential or retail destinations. Following the roadways, the nearest subdivision entrance is over 2 miles from the assumed 2010 Indirect Effects development site and the nearest retail establishment is over 1.5 miles away. Second, the estimated total number of local employees on site at any one time in 2010 (for both the IMF and Logistics Park Kansas City) would still be fairly modest (between 250 and 430). A third reason is the off-peak two-shift/three-shift nature of intermodal and warehouse work. Approximately 80 percent of the BNSF employees would work 12-hour shifts, with shift changes at 7:00 a.m. and 7:00 p.m. The warehouse employee work schedule could be a one-, two-, or even three-shift schedule.

Pedestrian activity may increase in the future if new development were to occur within walking distance of the warehouse development, but given the nature and dispersion of the on-site activity, it is not expected to be a major mode for the site in the foreseeable future.

Bicycle activity is expected to be minimal for the same reasons that pedestrian activity is expected to be minimal. In the near term, any bicycle activity associated with the facility would be adult work-based trips and these trips could be accommodated on the planned paved roadways (or sidewalks on 191st Street). In the longer term, the new arterial pathways on Waverly Road and 183rd Street could also be available.

Regarding the impact on the existing and proposed facilities, while there are no existing facilities that would be physically impacted by the Logistics Park Kansas City development, it could affect some of the proposed future facilities in the area. However, the City of Gardner has indicated that it expects to initiate a new Master Plan for trails and pathways later this year (2008). The City expects major changes to the proposed trails and pathways in the vicinity of the Proposed Action and the Logistics Park Kansas City to avoid conflicts with these planned developments. Therefore, the potential impacts described below are expected to be resolved through the completion of the updated Master Plan. Figure 3-26 illustrates the trails.

Figure 3-26: Potential Future Trails



- *Gardner Trail 1 (T1)* - The north-south trail that would cut through the project site would also potentially conflict with the Logistics Park Kansas City development. It would need to be rerouted, shortened, or eliminated. There are other routing options as outlined previously in Section 3.2.6.
- *Gardner Trail 2 (T2)* – The east-west trail along 183rd Street would divide the intermodal site and would also potentially be in conflict with the Indirect Effects development. It would need to be rerouted, shortened, or eliminated as outlined in Section 3.2.6.
- *Gardner Trail 3 (T3)* – This trail would intersect Waverly Road just north of 191st Street and then continue southwest across 191st Street. It could potentially be in conflict with the Logistics Park Kansas City development. One rerouting option would be to modify the plan to show the trail following Waverly south to 191st Street and then 191st Street west to reconnect with the prior trail alignment.
- *Pathway on Waverly Road (P1)* - The proposed pathway along Waverly Road can still be implemented as planned. It would run along the edge of a portion of the Logistics Park Kansas City development. As mentioned in Section 3.2.6, there is ongoing coordination between the roadway planners and the City regarding if and where trail facilities are needed along both Waverly Road and 191st Street consistent with the update of the Master Plan.

3.3.6 At-Grade Rail-Highway Crossings and Delay

The Logistics Park Kansas City development would not alter the projected train volumes or speeds. It would, however, increase traffic volumes, mainly over the Waverly Road crossing. Thus, the number of vehicles actually delayed at the Waverly crossing (during the p.m. peak hour) would increase by 5 in 2010, 56 in 2015, and 78 in 2030 compared to the Proposed Action and Future Gardner IMF Operations scenarios. The average delay to all vehicles and the average delay to delayed vehicles, however, would change very little regardless of the year ($\pm$ 3 seconds or less). Therefore, only minor indirect impacts to crossing delay are anticipated.

3.3.7 Emergency Vehicle Access

The Logistics Park Kansas City development would not result in any additional road closures or rail re-alignments. Therefore, no significant impacts are expected to emergency vehicle response distances or response times in the area.

3.3.8 Circulation System

In the Gardner IMF Operations plus Induced Development Scenario, the local and regional connectivity in the vicinity of the Gardner IMF would not change substantially as there would be few major highway modifications. The volume of traffic on the local roadways (especially Waverly Road) would increase. This would further highlight the importance of Waverly Road as a north-south arterial in the area. It was assumed in the traffic modeling that the new service road (between the IMF and the BNSF mainline tracks to the north) would ultimately connect to 191st Street (near Four Corners). This connection would provide development on the service road north of the IMF with additional options for reaching the regional highway system because there would be two ways to access that development area. Consistent with the 2030 Proposed Action scenario, it was also assumed in the traffic modeling that through trucks would be restricted from using both 183rd Street and 191st Street/188th Street between Waverly Road and Gardner Road.

3.3.9 Roadway Design Considerations

The Logistics Park Kansas City development would increase traffic volumes on some of the area roadways as outlined previously. In 2010 and 2015, much of the truck traffic would use Waverly Road and 191st Street to access Gardner Road and I-35. Both Waverly Road and 191st Street are anticipated to be upgraded as part of the Proposed Action in advance of the Logistics Park Kansas City development and in accordance with applicable design standards. Improvements to Gardner Road near I-35 are being made by KDOT as previously discussed. In the 2010 and 2015 Scenarios, the majority of IMF and Logistics Park Kansas City truck traffic are forecasted to use 191st Street and Gardner Road to travel to and from I-35. For example, in 2015, 202 out of 247 p.m. peak hour trucks leaving the IMF and Logistics Park Kansas City area are forecasted to use this route (over 81 percent)[2]. This would minimize any potential near-term effects on other local roadways.

Because the location of a new interchange has not been determined by KDOT, this analysis assumed the CARNP location for an interchange. By 2030, the new I-35 interchange at 199th Street and Waverly Road between the City of Gardner and the City of Edgerton was forecasted to attract the vast majority of IMF and Logistics Park Kansas City truck traffic. However, the trucks would use a combination of the new Waverly Road connection between 191st Street and 199th Street and the Four Corners connection to 199th Street to access this interchange. Also, 199th Street is anticipated to be improved (as called for in the CARNP plan), in response to area/corridor development needs as mentioned in the No Action Scenario. Therefore, Four Corners Road may be the one roadway in the 2030 Scenario that could experience truck volumes for which it was not designed. However, given the closure of Four Corners north of 191st Street, non-IMF and non-Logistics Park Kansas City traffic on that roadway would be minimal. One other point that should be mentioned is that while this analysis assumes that the new I-35 interchange

[2] As previously discussed, the 2015 analysis does not include the new interchange. However, it is included in the 2030 analysis.

will not be in service by 2015, it could be available by then or a short time after. When it is in service, the traffic patterns are expected to shift as explained for 2030, although 2015 volumes would be lower than the volumes predicted for 2030.

By 2030, the Logistics Park Kansas City truck routing is forecasted to shift to the new interchange.

Conflicts between school traffic and the combined Logistics Park Kansas City and IMF truck traffic are not anticipated because of the low volume of trucks from these sources traveling in front of the local schools. For example, in 2015 two trucks are projected to use Gardner Road south of I-35 (in the vicinity of the Nike Elementary School) during the 7:00 to 8:00 a.m. hour. On Waverly Road north of US 56, in 2015 two trucks are projected during this a.m. peak hour. No IMF trucks are projected to use US 56 just west of Waverly and 29 trucks are projected on US 56 east of Waverly road during the a.m. peak hour.

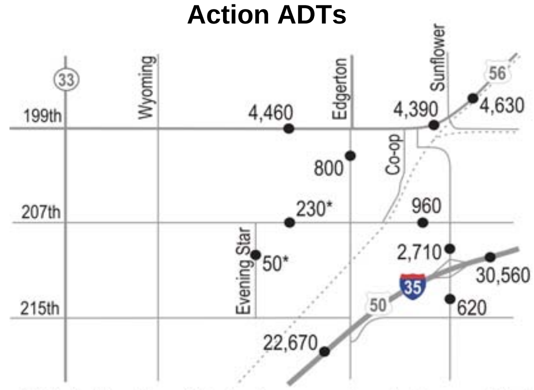
3.3.10 Construction Traffic

Construction of the Logistics Park Kansas City would begin sometime near the beginning of the Proposed Action construction activity. The first building would be completed within 12 to 24 months of the start of the Proposed Action depending on the exact start time, building size, location, market factors, and other key parameters. Construction of the building would include both the building itself and associated site improvements (such as parking, drainage, utilities, and on-site roadways). Construction staging areas would likely be on site. After construction of the first building, additional buildings are anticipated over the next five years. Therefore, construction activities would be beginning and ending at various locations over the course of this time period. It is not currently known how much construction traffic would be generated at any one time over the course of the construction of the Logistics Park Kansas City. A traffic management plan would address the issue of site access and egress including haul routes to and from the site as necessary.

3.4 Direct Effects – Wellsville North

This section includes traffic analysis of the Wellsville North Alternative located further to the south and west of the Gardner project site, near the City of Wellsville. The operational analysis uses the same methodology, but focuses on a different set of intersections that partially overlap the Gardner traffic study area (as previously discussed in Section 2.2). Detailed operational analysis sheets for intersections and freeway facilities are included in Appendix G.

Figure 3-27: 2010 Wellsville North No Action ADTs



*Estimated based on existing turning movement counts plus a growth factor

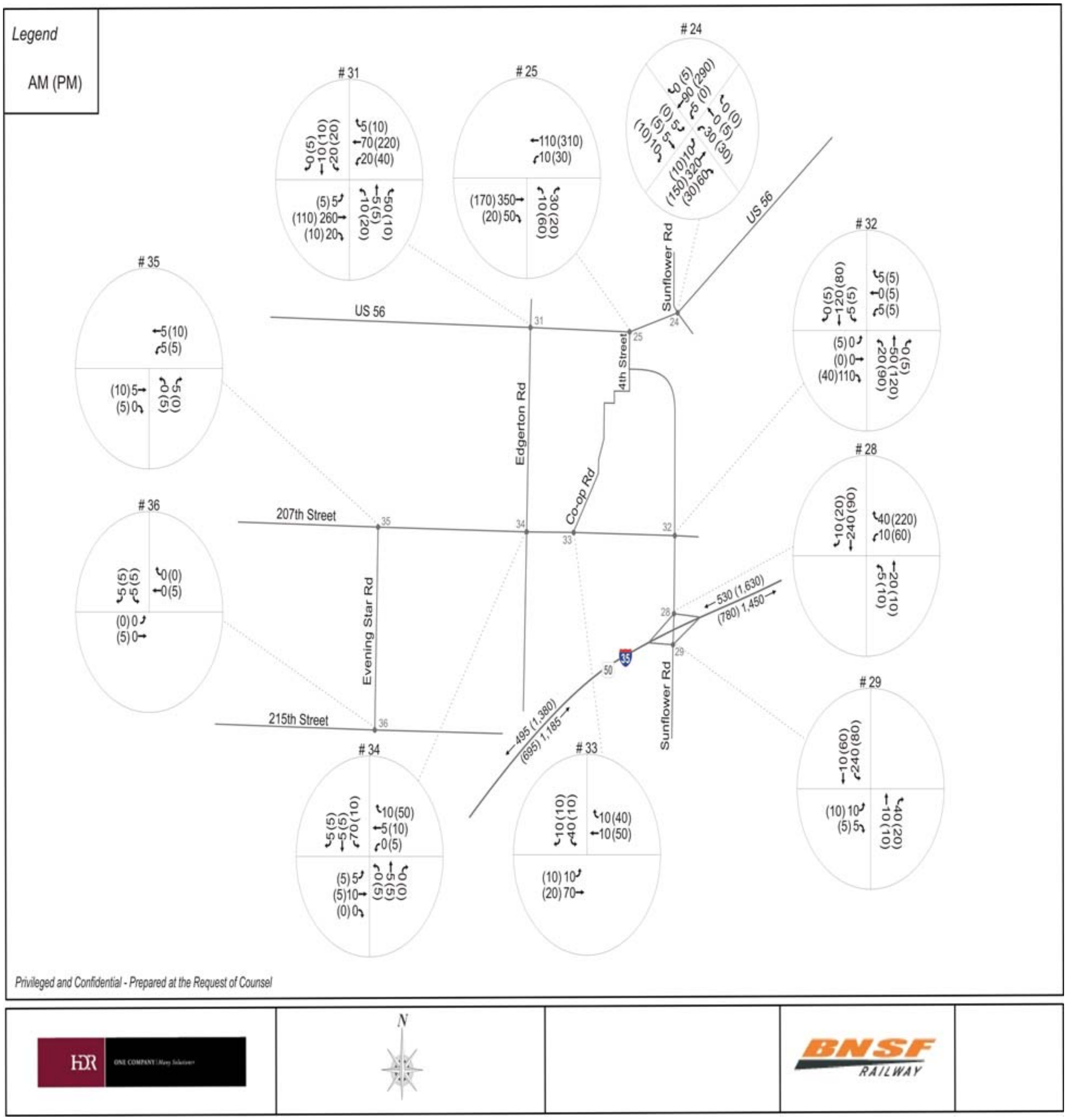
3.4.1 2010 Wellsville North No Action

2010 Wellsville North No Action Forecast Volumes

As with the Proposed Action, the 2010 Wellsville North Alternative No Action scenario is a near-term scenario for comparing opening day for this alternative. It assumes modest near-term traffic growth consistent with historical growth in the area. Based on KDOT traffic count data, and consistent with the recently completed I-35 Gardner BIA Study, a growth rate of 2.8 percent per year was assumed for intersections and a growth rate of approximately 3.2 percent per year was assumed for the I-35 mainline. These growth rates were applied to the existing (2008) volumes.

The resulting 2010 No Action ADT volumes and peak-hour turning-movement volumes are shown in Figures 3-27 and 3-28. The volumes are rounded, reflecting that they are forecasts. The peak hour truck percentages are illustrated in Appendix C.

Figure 3-28: 2010 Wellsville North No Action Turning Movement Volumes



<u>2010 Wellsville North No Action Geometry Assumptions</u>
Section 3.1.1 describes a set of near-term improvements that are planned in the Gardner study area, as well as "Improved No Action" improvements that could reasonably be expected to occur to accommodate growth in the area not associated with an IMF at the Wellsville North site (i.e., 2010 Gardner No Action scenario). Of these improvements, only two overlap with the Wellsville North study area, including signalization and associated improvements at *Intersections #8 (US*

56/I-35 SB Ramps) and *#9 (US 56/I-35 NB Ramps)*. No improvements beyond these were assumed for the 2010 Wellsville North Improved No Action scenario.

2010 Wellsville North No Action Intersection Analysis

A total of 18 intersections were examined using the projected 2010 No Action traffic volumes and the Improved 2010 No Action network assumptions described previously in this section. The results of this analysis are shown in Table 3-27. In this scenario, all study intersections are projected to operate at LOS C or better.

Table 3-27: 2010 Wellsville North Improved No Action Study Intersection Analysis

			Improved No Action Analysis			
			AM Peak Hour		PM Peak Hour	
	Location	Traffic Control	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
1	175th St/ Waverly Rd	TWSC	24.3 (SB)	C	14.2 (SB)	B
2	US 56/ Gardner Rd	Signalized	17.5	B	17.3	B
8	I-35 SB Ramps/ US 56	Signalized	12.8	B	9.7	A
9	I-35 NB Ramps/ US 56	Signalized	9.6	A	7.0	A
11	US 56/ Waverly Rd	TWSC	14.7 (NB)	B	12.8 (SB)	B
13	183rd St/ US 56	TWSC	13.1 (EB)	B	13.3 (WB)	B
16	US 56/ Four Corners Rd	TWSC	12.4 (NB)	B	12.6 (NB)	B
17	191st St/ US 56	TWSC	12.7 (EB)	B	13.5 (WB)	B
24	US 56/ Sunflower Rd	TWSC	15.2 (NW)	C	15.5 (NW)	C
25	US 56/ E 4th St	OWSC	12.5 (NB)	B	15.4 (NB)	C
28	I-35 SB Ramps & Sunflower Rd	OWSC	9.2 (WB)	A	10.3 (WB)	B
29	I-35 NB Ramps & Sunflower Rd	OWSC	13.3 (EB)	B	10.0 (EB)	B
31	199th & Edgerton	TWSC	13.3 (SB)	B	12.8 (SB)	B
32	207th & Sunflower	TWSC	10.9 (WB)	B	12.4 (WB)	B
33	207th & Co-op Road	OWSC	9.5 (SB)	A	9.2 (SB)	A
34	207th & Edgerton	AWSC	7.8	A	7.5	A
35	207th & Evening Star	OWSC	8.4 (NB)	A	8.9 (NB)	A
36	215th & Evening Star	OWSC	8.5 (SB)	A	8.5 (SB)	A

Notes: TWSC – Two-way STOP control, OWSC – One-way STOP control, AWSC – All-way STOP control, LOS – Level of Service.
For one and two-way STOP-controlled intersections the delay and LOS for the worst approach is shown.

2010 Wellsville North No Action Freeway/Ramp Analysis

Table 3-28: 2010 Wellsville North No Action Freeway/Ramp Analysis

		AM Peak Hour		PM Peak Hour	
Location	Lanes	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS
Basic Freeway Segments					
I-35 NB					
Edgerton to Sunflower	2	9.8	A	6.1	A
Sunflower to Waverly	2	12.0	B	6.8	A
Gardner to US 56	2	15.9	B	8.3	A
I-35 SB					
US 56 to Gardner	2	5.0	A	17.3	B
Waverly to Sunflower	2	4.6	A	13.6	B
Sunflower to Edgerton	2	4.3	A	11.7	B
Ramp Merge/Diverge					
I-35 NB					
Sunflower Road Off	N/A	8.9	A	4.4	A
Sunflower Road On	N/A	13.4	B	7.8	A
Gardner Road Off	N/A	11.5	B	5.2	A
Gardner Road On	N/A	17.7	B	9.5	A
I-35 SB					
Gardner Road Off	N/A	3.1	A	17.8	B
Gardner Road On	N/A	5.4	A	15.2	B
Sunflower Road Off	N/A	2.6	A	13.5	B
Sunflower Road On	N/A	5.1	A	13.1	B

Notes: pc/mi/ln – passenger cars per mile per lane, LOS – Level of Service

The 2010 Wellsville North No Action freeway analysis assumes the forecasted volumes presented in Figure 3-28 and the current mainline and ramp geometry. The resulting operational analysis (for both mainline and ramp junctions) is summarized in Table 3-28. As the table indicates, all locations are forecasted to operate at an acceptable LOS of D or better during both peak hours.

3.4.2 2010 Wellsville North Alternative

2010 Wellsville North Alternative Forecast Volumes

To develop traffic forecasts for this analysis, the same intermodal trip generation assumptions were applied that were used for the 2010 Proposed Action scenario, resulting in 2,900 vpd, including 273 during the a.m. peak hour and 185 during the p.m. peak hour. Traffic was distributed and assigned to the network using the same methodology used for the 2010 Proposed Action scenario (Appendix A).

The resulting 2010 Wellsville North Alternative ADT volumes and peak-hour turning-movement volumes are shown in Figures 3-29 and 3-30. The volumes are rounded, reflecting that they are forecasts. The peak hour truck percentages are illustrated in Appendix C.

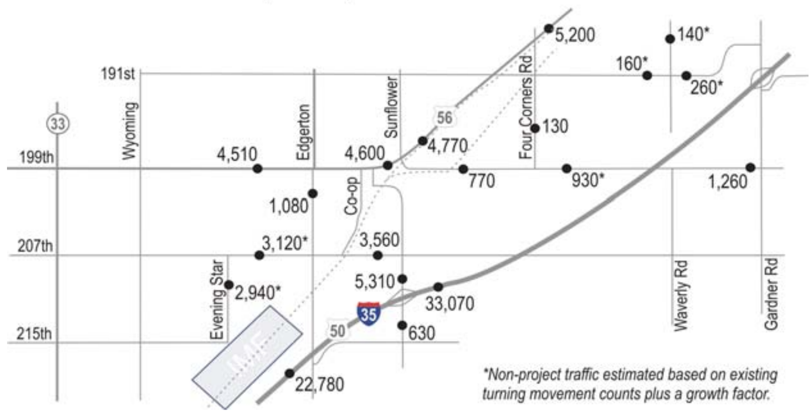
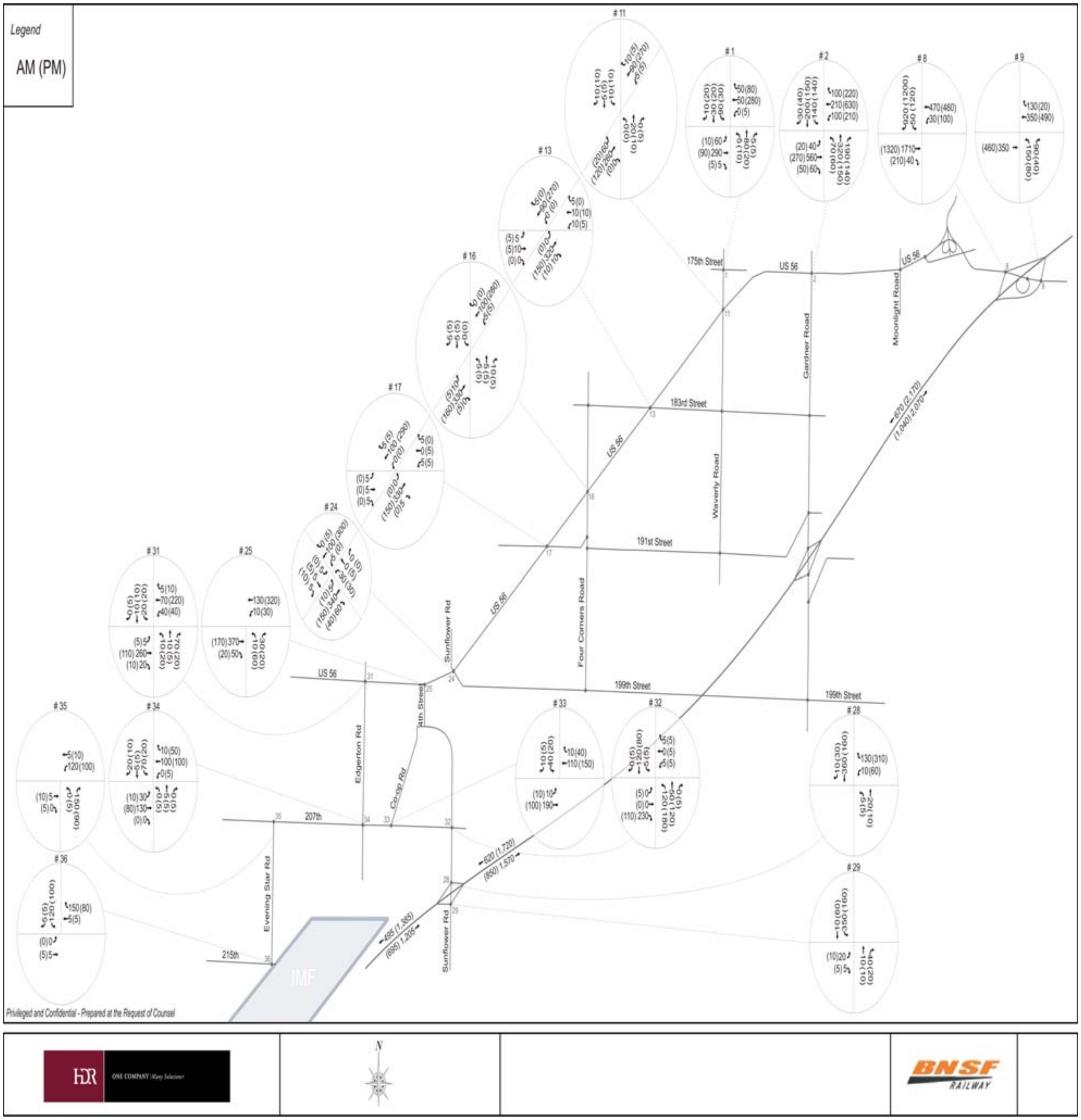


Figure 3-29: 2010 Wellsville North Alternative ADTs

2010 Wellsville North Alternative Geometry Assumptions

For purposes of analyses of the Wellsville North Alternative, it was assumed that certain improvements would be necessary to be able to accommodate construction and operation of an IMF at the Wellsville site. These assumptions include upgrading both Evening Star Road and 207th Street to provide needed pavement sections and widths to support the intermodal truck traffic. In addition, improvements at Intersections 8 and 9 were assumed to be constructed without the IMF (“Improved No Action”).

Figure 3-30: 2010 Wellsville North Alternative Turning Movement Volumes



2010 Wellsville North Alternative Intersection Analysis

The results of the intersection analysis for this scenario are summarized in Table 3-29. As the table indicates, all intersections analyzed for the Wellsville North scenario are projected to continue to operate at LOS D or better. Therefore, minor impacts to intersections are anticipated.

Table 3-29: 2010 Wellsville North Improved No Action and Wellsville Alternative Study Intersection Analysis

			Improved No Action Analysis				Wellsville North Alternative Analysis			
			AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
	Location	Traffic Control	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
1	175th St/ Waverly Rd	TWSC	24.3 (SB)	C	14.2 (SB)	B	25.0 (SB)	D	14.2 (SB)	B
2	US 56/ Gardner Rd	Signalized	17.5	B	17.3	B	18	B	17.5	B
8	I-35 SB Ramps/ US 56	Signalized	12.8	B	9.7	A	13.8	B	40.7	D
9	I-35 NB Ramps/ US 56	Signalized	9.6	A	7.0	A	13.6	B	7.0	A
11	US 56/ Waverly Rd	TWSC	14.7 (NB)	B	12.8 (SB)	B	15.1 (NB)	C	12.9 (SB)	B
13	183rd St/ US 56	TWSC	13.1 (EB)	B	13.3 (WB)	B	13.4 (EB)	B	13.3 (EB)	B
16	US 56/ Four Corners Rd	TWSC	12.4 (NB)	B	12.6 (NB)	B	12.8 (NB)	B	12.8 (NB)	B
17	191st St/ US 56	TWSC	12.7 (EB)	B	13.5 (WB)	B	12.3 (WB)	B	13.6 (WB)	B
24	US 56/ Sunflower Rd	TWSC	15.2 (NW)	C	15.5 (NW)	C	15.6 (NW)	C	16.1 (NW)	C
25	US 56/ E 4th St	OWSC	12.5 (NB)	B	15.4 (NB)	C	12.9 (NB)	B	15.6 (NB)	C
28	I-35 SB Ramps/Sunflower Rd	OWSC	9.2 (WB)	A	10.3 (WB)	B	9.9 (WB)	A	12.0 (WB)	B
29	I-35 NB Ramps/Sunflower Rd	OWSC	13.3 (EB)	B	10.0 (EB)	B	21.4 (EB)	C	12.2 (EB)	B
31	199th & Edgerton	TWSC	13.3 (SB)	B	12.8 (SB)	B	14.7 (SB)	B	13.0 (SB)	B
32	207th & Sunflower	TWSC	10.9 (WB)	B	12.4 (WB)	B	17.9 (WB)	C	17.5 (WB)	C
33	207th & Co-op Road	OWSC	9.5 (SB)	A	9.2 (SB)	A	11.6 (SB)	B	11.0 (SB)	B
34	207th & Edgerton	AWSC	7.8	A	7.5	A	11.6 (EB)	B	10.7 (WB)	B
35	207th & Evening Star	OWSC	8.4 (NB)	A	8.9 (NB)	A	10.7 (NB)	B	10.7 (NB)	B
36	215th & Evening Star	OWSC	8.5 (SB)	A	8.5 (SB)	A	12.4 (SB)	B	12.0 (SB)	B

Notes: TWSC – Two-way STOP control, OWSC – One-way STOP control, AWSC – All-way STOP control, LOS – Level of Service.
For one and two-way STOP-controlled intersections the delay and LOS for the worst approach is shown.

2010 Wellsville North Alternative Freeway/Ramp Analysis

Table 3-30 summarizes the results of the freeway analysis for this scenario. As the table indicates, all freeway segments and ramps analyzed for the Wellsville North scenario are projected to continue to operate at LOS C or better with the Wellsville North Alternative. Therefore, minor impacts are predicted.

Table 3-30: 2010 Wellsville North Alternative Freeway/Ramp Analysis

		AM Peak Hour		PM Peak Hour	
Location	Lanes	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS
Basic Freeway Segments					
I-35 NB					
Edgerton to Sunflower	2	10.0	A	6.0	A
Sunflower to Waverly	2	13.2	B	7.6	A
Gardner to US 56	2	17.3	B	9.2	A
I-35 SB					
US 56 to Gardner	2	5.9	A	18.3	C
Waverly to Sunflower	2	5.5	A	14.7	B
Sunflower to Edgerton	2	4.3	A	11.7	B
Ramp Merge/Diverge					
I-35 NB					
Sunflower Road Off	N/A	9.1	A	4.3	A
Sunflower Road On	N/A	15.3	B	8.3	A
Gardner Road Off	N/A	13.0	B	6.2	A
Gardner Road On	N/A	19.0	B	10.4	B
I-35 SB					
Gardner Road Off	N/A	4.2	A	19.1	B
Gardner Road On	N/A	6.4	A	16.3	B
Sunflower Road Off	N/A	3.7	A	14.7	B
Sunflower Road On	N/A	5.3	A	13.4	B

Notes: pc/mi/ln – passenger cars per mile per lane, LOS – Level of Service.

3.5 Indirect Effects – Future Wellsville North IMF Operations

3.5.1 2015 Wellsville North No Action

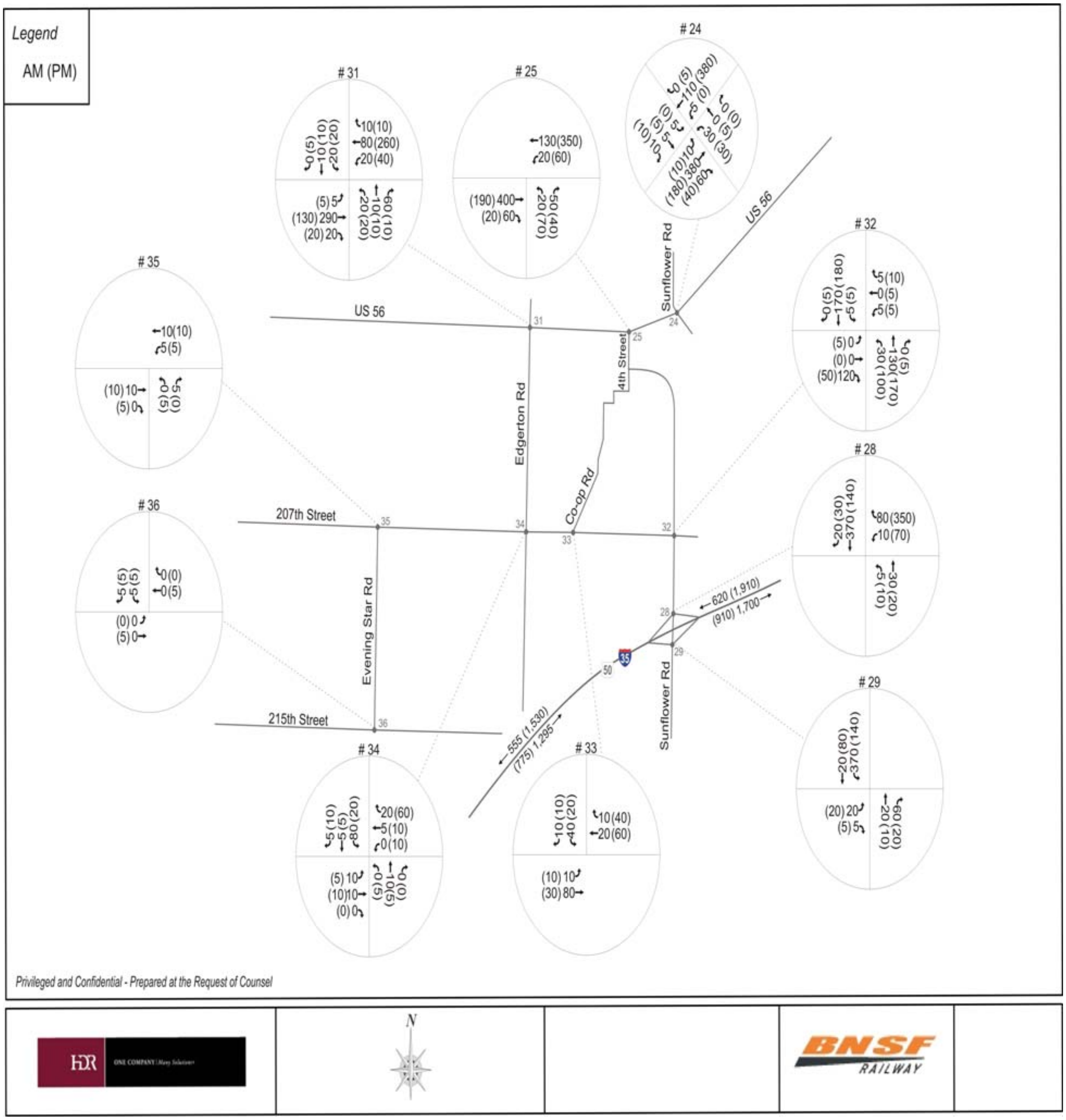
<u>2015 Wellsville North No Action Forecast Volumes</u>
As with the analysis of the Proposed Action, the 2015 Wellsville North Alternative scenario is a near-term scenario for comparing No Action conditions with those of the Wellsville North Alternative five years after opening day. It assumes modest near-term traffic growth consistent with historical growth in the area. Based on KDOT count data, and consistent with the recently completed I-35 Gardner BIA Study, a growth rate of 2.8 percent per year was assumed for intersections and a growth rate of approximately 3.2 percent per year was assumed for the I-35 mainline. These growth rates were applied to the existing (2008) volumes.

Figure 3-31: 2015 Wellsville North No Action ADTs

The resulting 2015 No Action ADT volumes and peak-hour turning movement volumes are illustrated in Figures 3-31 and 3-32. Peak-hour truck percentages are illustrated in Appendix C.

<u>2015 Wellsville North No Action Geometry Assumptions</u>
The 2015 Wellsville North No Action geometry assumptions are identical to those of the 2010 Wellsville North Improved No Action scenario (signalization and associated improvements at Intersections 8 and 9).

Figure 3-32: 2015 Wellsville North No Action Turning Movement Volumes



<u>2015 Wellsville North No Action Intersection Analysis</u>

Table 3-31 summarizes the results of the intersection analysis for this scenario. As Table 3-31 indicates, all study intersections are projected to operate at LOS C or better. Detailed intersection analysis sheets for the Wellsville North No Action scenarios are included in Appendix G.

Table 3-31: 2015 Wellsville North Improved No Action Study Intersection Analysis

			Improved No Action Analysis			
			AM Peak Hour		PM Peak Hour	
	Location	Traffic Control	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
1	175th St/ Waverly Rd	AWSC	15.1	C	12.3	B
2	US 56/ Gardner Rd	Signalized	24.9	C	27.1	C
8	I-35 SB Ramps/ US 56	Signalized	13.5	B	16.7	B
9	I-35 NB Ramps/ US 56	Signalized	12.2	B	7.0	A
11	US 56/ Waverly Rd	TWSC	16.1 (NB)	C	13.0 (SB)	B
13	183rd St/ US 56	TWSC	14.2 (EB)	B	14.5 (WB)	B
16	US 56/ Four Corners Rd	TWSC	13.3 (NB)	B	13.8 (NB)	B
17	191st St/ US 56	TWSC	13.7 (EB)	B	14.5 (WB)	B
24	US 56/ Sunflower Rd	TWSC	17.2 (NW)	C	18.9 (NW)	C
25	US 56/ E 4th St	OWSC	14.6 (NB)	B	19.0 (NB)	C
28	I-35 SB Ramps & Sunflower Rd	OWSC	9.4 (WB)	A	12.2 (WB)	B
29	I-35 NB Ramps & Sunflower Rd	OWSC	23.0 (EB)	C	12.0 (EB)	B
31	199th & Edgerton	TWSC	14.3 (SB)	B	13.8 (SB)	B
32	207th & Sunflower	TWSC	12.9 (WB)	B	13.8 (WB)	B
33	207th & Co-op Road	OWSC	9.6 (SB)	A	9.6 (SB)	A
34	207th & Edgerton	AWSC	7.8	A	7.4	A
35	207th & Evening Star	OWSC	8.4 (NB)	A	8.9 (NB)	A
36	215th & Evening Star	OWSC	8.5 (SB)	A	8.5 (SB)	A

Notes: TWSC – Two-way STOP control, OWSC – One-way STOP control, AWSC – All-way STOP control, LOS – Level of Service.
For one and two-way STOP-controlled intersections the delay and LOS for the worst approach is shown.

<u>2015 Wellsville North No Action Freeway/Ramp Analysis</u>

The 2015 Wellsville North No Action freeway analysis assumes the forecasted volumes presented in Figure 3-32 and the current mainline and ramp geometry. The resulting operational analysis (for both mainline and ramp junctions) is summarized in Table 3-32. As the table indicates, all locations are fore-casted to operate at an acceptable LOS of C or better during both peak hours. Detailed freeway analysis sheets for the Wellsville North No Action scenarios are included in Appendix G.

Table 3-32: 2015 Wellsville North No Action Freeway/Ramp Analysis

		AM Peak Hour		PM Peak Hour	
Location	Lanes	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS
Basic Freeway Segments					
I-35 NB					
Edgerton to Sunflower	2	10.8	A	6.8	A
Sunflower to Waverly	2	14.0	B	7.9	A
Gardner to US 56	2	18.6	C	9.7	A
I-35 SB					
US 56 to Gardner	2	5.8	A	20.1	C
Waverly to Sunflower	2	5.4	A	16.0	B
Sunflower to Edgerton	2	4.8	A	12.9	B
Ramp Merge/Diverge					
I-35 NB					
Sunflower Road Off	N/A	10.0	B	5.2	A
Sunflower Road On	N/A	15.6	B	9.0	A
Gardner Road Off	N/A	13.9	B	6.5	A
Gardner Road On	N/A	20.5	C	11.0	B
I-35 SB					
Gardner Road Off	N/A	4.0	A	21.2	C
Gardner Road On	N/A	6.3	A	17.7	B
Sunflower Road Off	N/A	3.5	A	16.3	B
Sunflower Road On	N/A	5.7	A	14.4	B

3.5.2 2015 Wellsville North Alternative

<u>2015 Wellsville North Alternative Forecast Volumes</u>
To develop traffic forecasts for this scenario, the same intermodal trip generation assumptions were applied that were used for the 2015 Gardner IMF Operations scenario, resulting in nearly 3,500 vpd, including 335 during the a.m. peak hour and 222 during the p.m. peak hour. Traffic was distributed and assigned to the network using the same methodology used for the 2015 Gardner IMF Operations scenario (Appendix A).

The resulting 2015 Wellsville North Alternative ADT volumes and peak-hour turning-movement volumes are shown in Figures 3-33 and 3-34. The volumes are rounded, reflecting that they are forecasts. Peak hour truck percentages are illustrated in Appendix C.

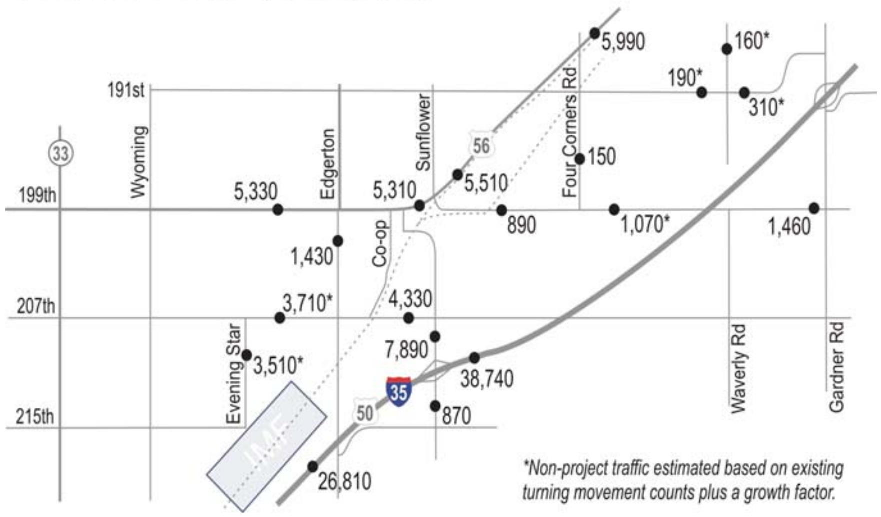


Figure 3-33: 2015 Wellsville North Alternative ADTs

<u>2015 Wellsville North Alternative Geometry Assumptions</u>
For purposes of analyses of the Wellsville North Alternative, it was assumed that certain improvements would be necessary to be able to accommodate construction and operation of an IMF at the Wellsville site (similar to the 2010 scenario). These assumptions include upgrading both Evening Star Road and 207th Street to provide needed pavement sections and widths to support the intermodal truck traffic. In addition, improvements at Intersections 8 and 9 were assumed to be constructed without the IMF ("Improved No Action").

<u>2015 Wellsville North Alternative Intersection Analysis</u>
Table 3-33 summarizes the results of the intersection analysis for this scenario, in comparison to the Wellsville North No Action scenario. Detailed intersection analysis sheets for the Future Wellsville North Alternative IMF Operations scenarios are presented in Appendix G. As the table indicates, the eastbound approach to Intersection 29 (I-35 Northbound Ramps/Sunflower Road) is forecasted to operate at LOS E during the a.m. peak hour. Potential mitigation measures to address this significant impact are discussed in the *Mitigation Technical Report* (HDR, 2008c).

<u>2015 Wellsville North Alternative Freeway/Ramp Analysis</u>
The 2015 Wellsville North Alternative freeway analysis assumes the forecasted volumes presented in Figure 3-34 and the current mainline and ramp geometry. The resulting operational analysis (for both mainline and ramp junctions) is summarized in Table 3-34 (Detailed freeway facility analysis sheets for the Future Wellsville North Alternative IMF Operations scenarios are presented in Appendix G). As the table indicates, all locations are forecasted to operate at an acceptable LOS of D or better during both peak hours. Therefore, the Wellsville North Alternative is not anticipated to impact freeway segments or ramps.

Figure 3-34: 2015 Wellsville North Alternative Turning Movement Volumes

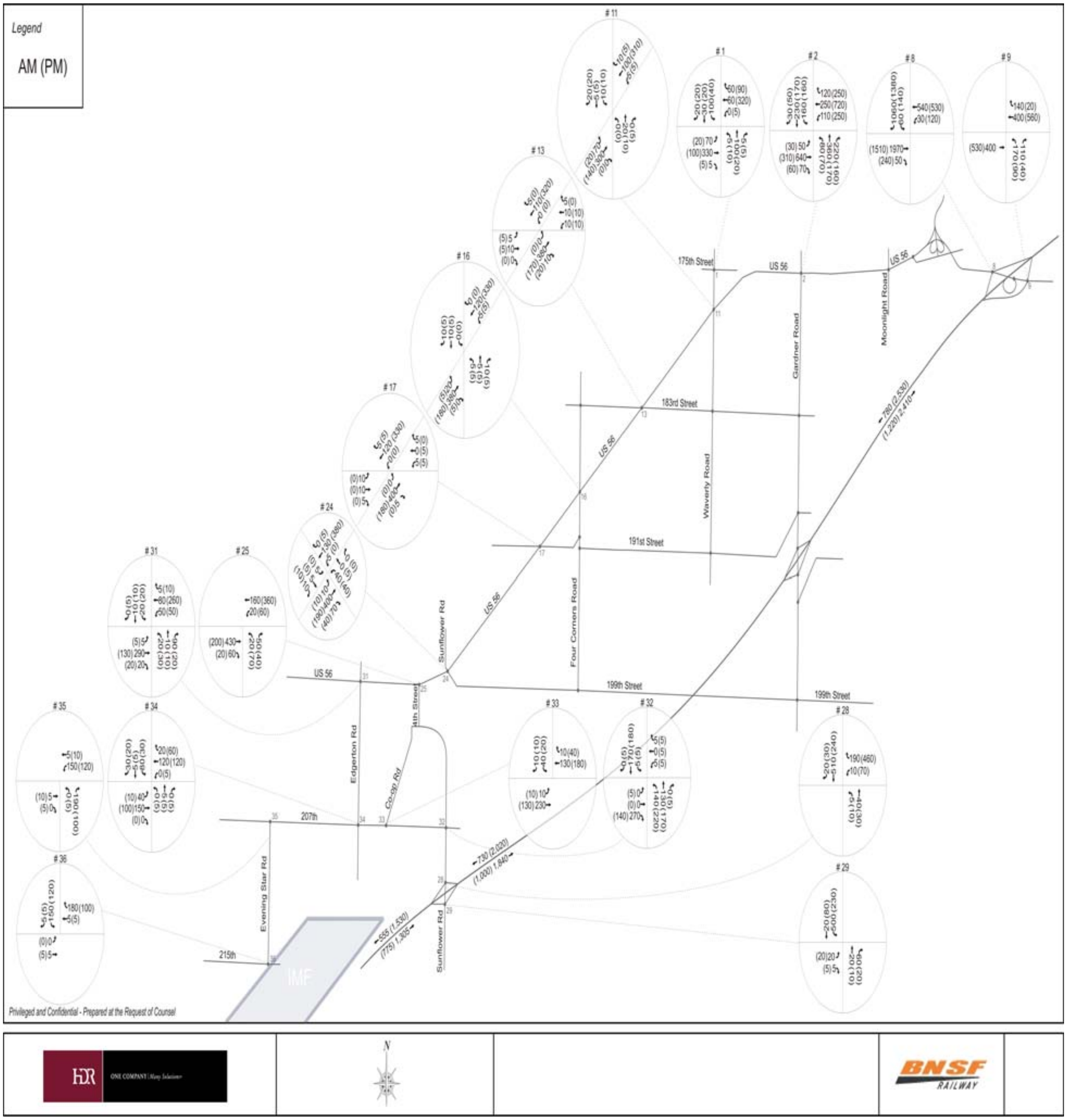


Table 3-33: 2015 Wellsville North Improved No Action and Alternative Study Intersection Analysis

			Improved No Action Analysis				Wellsville North Alternative Analysis			
			AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
	Location	Traffic Control	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
1	175th St/ Waverly Rd	AWSC	15.1	C	12.3	B	15.3	C	12.3	B
2	US 56/ Gardner Rd	Signalized	24.9	C	27.1	C	36.7	D	30.7	C
8	I-35 SB Ramps/ US 56	Signalized	13.5	B	16.7	B	16.9	B	34.8	C
9	I-35 NB Ramps/ US 56	Signalized	12.2	B	7.0	A	14.5	B	8.4	A
11	US 56/ Waverly Rd	TWSC	16.1 (NB)	C	13.0 (SB)	B	16.5 (NB)	C	13.2 (SB)	B
13	183rd St/ US 56	TWSC	14.2 (EB)	B	14.5 (WB)	B	14.7 (EB)	B	14.8 (WB)	B
16	US 56/ Four Corners Rd	TWSC	13.3 (NB)	B	13.8 (NB)	B	14.2 (NB)	B	13.7 (NB)	B
17	191st St/ US 56	TWSC	13.7 (EB)	B	14.5 (WB)	B	14.4 (EB)	B	14.8 (WB)	B
24	US 56/ Sunflower Rd	TWSC	17.2 (NW)	C	18.9 (NW)	C	19.3 (NW)	C	20.4 (NW)	C
25	US 56/ E 4th St	OWSC	14.6 (NB)	B	19.0 (NB)	C	15.4 (NB)	C	19.7 (NB)	C
28	I-35 SB Ramps & Sunflower Rd	OWSC	9.4 (WB)	A	12.2 (WB)	B	10.6 (wb)	B	16.7 (WB)	C
29	I-35 NB Ramps & Sunflower Rd	OWSC	23.0 (EB)	C	12.0 (EB)	B	48.1 (EB)	E	16.0 (EB)	C
31	199th & Edgerton	TWSC	14.3 (SB)	B	13.8 (SB)	B	16.6 (SB)	C	14.5 (SB)	B
32	207th & Sunflower	TWSC	12.9 (WB)	B	13.8 (WB)	B	28.1 (WB)	D	28.1 (WB)	D
33	207th & Co-op Road	OWSC	9.6 (SB)	A	9.6 (SB)	A	12.4 (SB)	B	11.4 (SB)	B
34	207th & Edgerton	AWSC	7.8	A	7.4	A	11.9	B	11.1	B
35	207th & Evening Star	OWSC	8.4 (NB)	A	8.9 (NB)	A	11.4 (NB)	B	11.1 (NB)	B
36	215th & Evening Star	OWSC	8.5 (SB)	A	8.5 (SB)	A	14.1 (SB)	B	13.0 (SB)	B

Notes: TWSC – Two-way STOP control, OWSC – One-way STOP control, AWSC – All-way STOP control, LOS – Level of Service.
Bold indicates a LOS below the acceptable threshold.
For one and two-way STOP-controlled intersections the delay and LOS for the worst approach is shown.

Table 3-34: 2015 Wellsville North Alternative Freeway/Ramp Analysis

		AM Peak Hour		PM Peak Hour	
Location	Lanes	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS
Basic Freeway Segments					
I-35 NB					
Edgerton to Sunflower	2	10.9	A	6.8	A
Sunflower to Waverly	2	14.1	B	7.9	A
Gardner to US 56	2	19.9	C	10.7	A
I-35 SB					
US 56 to Gardner	2	6.8	A	21.4	C
Waverly to Sunflower	2	5.5	A	16	B
Sunflower to Edgerton	2	4.9	A	12.9	B
Ramp Merge/Diverge					
I-35 NB					
Sunflower Road Off	N/A	10.1	B	5.3	A
Sunflower Road On	N/A	15.7	B	9.0	A
Gardner Road Off	N/A	14	B	6.6	A
Gardner Road On	N/A	22.6	C	11.5	B
I-35 SB					
Gardner Road Off	N/A	5.3	A	22.7	C
Gardner Road On	N/A	6.5	A	18.1	B
Sunflower Road Off	N/A	3.6	A	16.3	B
Sunflower Road On	N/A	5.8	A	14.4	B

Notes: pc/mi/ln – passenger cars per mile per lane, LOS – Level of Service.

3.5.3 2030 Wellsville North No Action

2030 Wellsville North No Action Forecast Volumes

Like the 2030 Gardner No Action scenario, the 2030 Wellsville North No Action scenario is a long-term scenario for comparing No Action and Wellsville North Alternative conditions based on a 20-year time horizon from opening year. The forecasts developed for this scenario were developed using a combination of the Olathe regional travel demand model (at its southwestern fringe), growth factors, and known growth plans in Edgerton. The assumptions and the forecasting process are presented in detail in Appendix A.

As in the 2030 Gardner scenarios, the majority of the study segments are projected to experience appreciable traffic growth in the 2030 Wellsville North No Action scenario. Figure 3-35 illustrates the forecasted ADTs for this scenario; Figure 3-36 illustrates the forecasted turning movements. Peak hour truck percentages are illustrated in Appendix C.

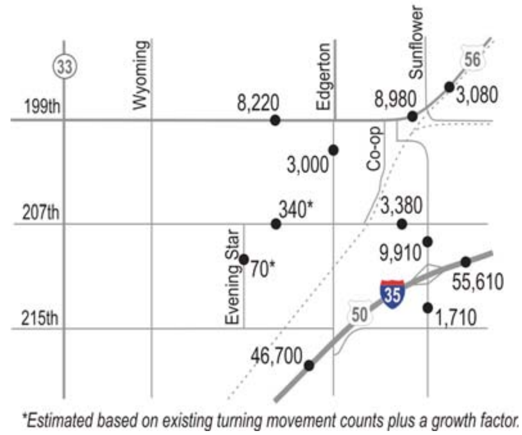


Figure 3-35: 2030 Wellsville North No Action ADTs

2030 Wellsville North No Action Geometry Assumptions

In addition to the improvements included in the 2030 Gardner No Action scenario, the Wellsville North No Action roadway network geometry includes a number of assumed enhancements to attempt to provide sufficient capacity for the projected 2030 No Action traffic. This includes signalization of both I-35/Sunflower Road ramps (Intersections #28 and 29) and conversion of intersection #31 (199th Street/Edgerton Road) to all-way stop control.

2030 Wellsville North No Action Intersection Analysis

The intersection analysis is summarized in Table 3-35. As the table indicates, two intersections are forecasted to operate at LOS E or worse under this scenario:

- *Intersection #8 (I-35 Southbound Ramps/US 56*): As in the Gardner No Action scenario, this intersection is projected to operate at LOS F during both peak hours. As described under the Gardner No Action scenario, the forecasts indicate that US 56 will need to be widened to three basic lanes in each direction by 2030.
- *Intersection #32 (207th Street/Sunflower Road):* The westbound approach is forecasted to operate at LOS E during both peak hours. The failing movement (left turns) is too small (five vehicles or less) to warrant improvements.

These long-term potential impacts are not related to an IMF at the Wellsville site.

2030 Wellsville North No Action Freeway/Ramp Analysis

The operational analysis (for both mainline and ramp junctions) is summarized in Table 3-36. As the table indicates, all locations are forecasted to operate at an acceptable LOS of D or better during both peak hours.

Figure 3-36: 2030 Wellsville North No Action Turning Movement Volumes

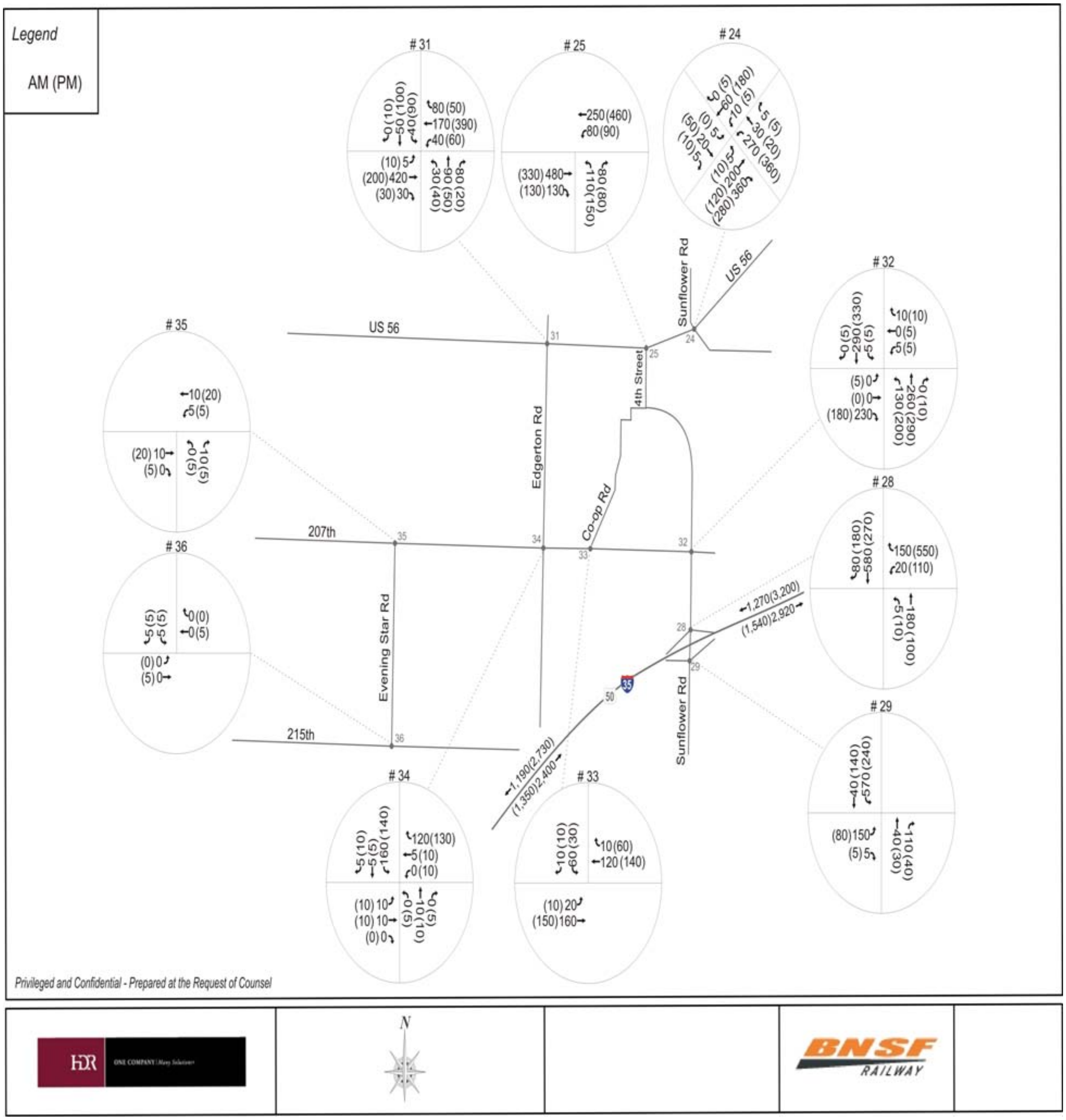


Table 3-35: 2030 Wellsville North Improved No Action Study Intersection Analysis

	Location	Traffic Control	AM Peak Hour Delay (sec/veh)	AM Peak Hour LOS	PM Peak Hour Delay (sec/veh)	PM Peak Hour LOS
1	175th St/ Waverly Rd	Signalized	19.0	B	15.4	B
2	US 56/ Gardner Rd	Signalized	29.1	C	27.2	C
8	I-35 SB Ramps/ US 56	Signalized	119.3	F	184.3	F
9	I-35 NB Ramps/ US 56	Signalized	21.0	C	12.5	B
11	US 56/ Waverly Rd	Signalized	25.8	C	34	C
13	183rd St/ US 56	TWSC	12.4 (WB)	B	13.4 (EB)	B
16	US 56/ Four Corners Rd	TWSC	15.8 (SB)	C	18.2 (NB)	C
17	191st St/ US 56	TWSC	11.0 (EB)	B	11.4 (EB)	B
24	US 56/ Sunflower Rd	Signalized	19.0	B	19.3	B
25	US 56/ E 4th St	Signalized	10.9	B	11.7	B
28	I-35 SB Ramps & Sunflower Rd	Signalized	9.4	A	25.9	C
29	I-35 NB Ramps & Sunflower Rd	Signalized	14.4	B	8.9	A
31	199th & Edgerton	AWSC	18.2	C	21.6	C
32	207th & Sunflower	TWSC	28.7 (WB)	D	39.7 (WB)	E
33	207th & Co-op Road	OWSC	12.3 (SB)	B	11.7 (SB)	B
34	207th & Edgerton	AWSC	9.2	A	9.0	A
35	207th & Evening Star	OWSC	8.4 (NB)	A	8.8 (NB)	A
36	215th & Evening Star	OWSC	8.5 (SB)	A	8.5 (SB)	A

Notes: TWSC – Two-way STOP control, OWSC – One-way STOP control, AWSC – All-way STOP control, LOS – Level of Service.
Bold indicates a LOS below the acceptable threshold.
For one and two-way STOP-controlled intersections the delay and LOS for the worst approach is shown.

Table 3-36: 2030 Wellsville North No Action Freeway/Ramp Analysis

Location	Lanes	AM Peak Hour Density (pc/mi/ln)	AM Peak Hour LOS	PM Peak Hour Density (pc/mi/ln)	PM Peak Hour LOS
Basic Freeway Segments					
I-35 NB					
Edgerton to Sunflower	2	19.9	C	11.8	B
Sunflower to Waverly	2	24.5	C	13.4	B
Waverly to Gardner	3	17.9	B	11.2	B
Gardner to US 56	3	24.1	C	15.5	B
I-35 SB					
US 56 to Gardner	3	12.8	B	26.5	D
Gardner to Waverly	3	9.3	A	19.2	C
Waverly to Sunflower	2	11	B	28	D
Sunflower to Edgerton	2	10.4	A	23.2	C
Ramp Merge/Diverge					
I-35 NB					
Sunflower Road Off	N/A	21	C	11.3	B
Sunflower Road On	N/A	26.5	C	14.9	B
Waverly Road Off	N/A	26.1	C	13.2	B
Waverly Road On	N/A	19.9	B	13.0	B
Gardner Road Off	N/A	19.3	B	11.7	B
Gardner Road On	N/A	28.5	D	19.0	B
I-35 SB					
Gardner Road Off	N/A	15.1	B	29.5	D
Gardner Road On	N/A	10.0	B	20.5	C
Waverly Road Off	N/A	10.0	A	21.1	C
Waverly Road On	N/A	12.2	B	29.3	D
Sunflower Road Off	N/A	10.3	B	29.3	D
Sunflower Road On	N/A	11.7	B	25.3	C

Notes: pc/mi/ln – passenger cars per mile per lane, LOS – Level of Service.

3.5.4 2030 Wellsville North Alternative

<u>2030 Wellsville North Alternative Forecast Volumes</u>

Since essentially the entire study area is outside the OTM, an alternative methodology was used to assign the traffic from the Wellsville North Alternative to the surrounding roadway network. The methodology, described in more detail in Appendix A, involved the use of the TRAFFIX software and the development of paths and distribution assumptions based on knowledge of existing and expected travel patterns in the study area.

The resulting 2030 Wellsville North Alternative ADT volumes and peak-hour turning movement volumes are illustrated in Figures 3-37 and 3-38. The peak hour truck percentages are presented in Appendix C.

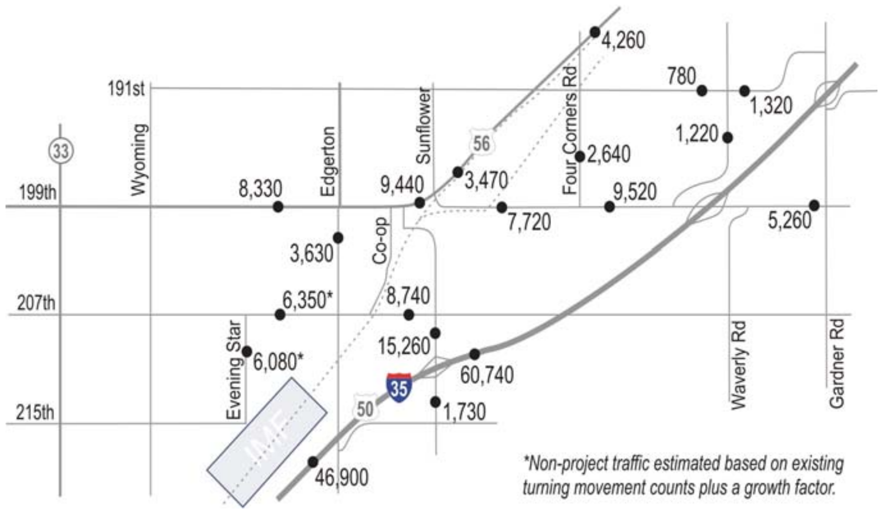
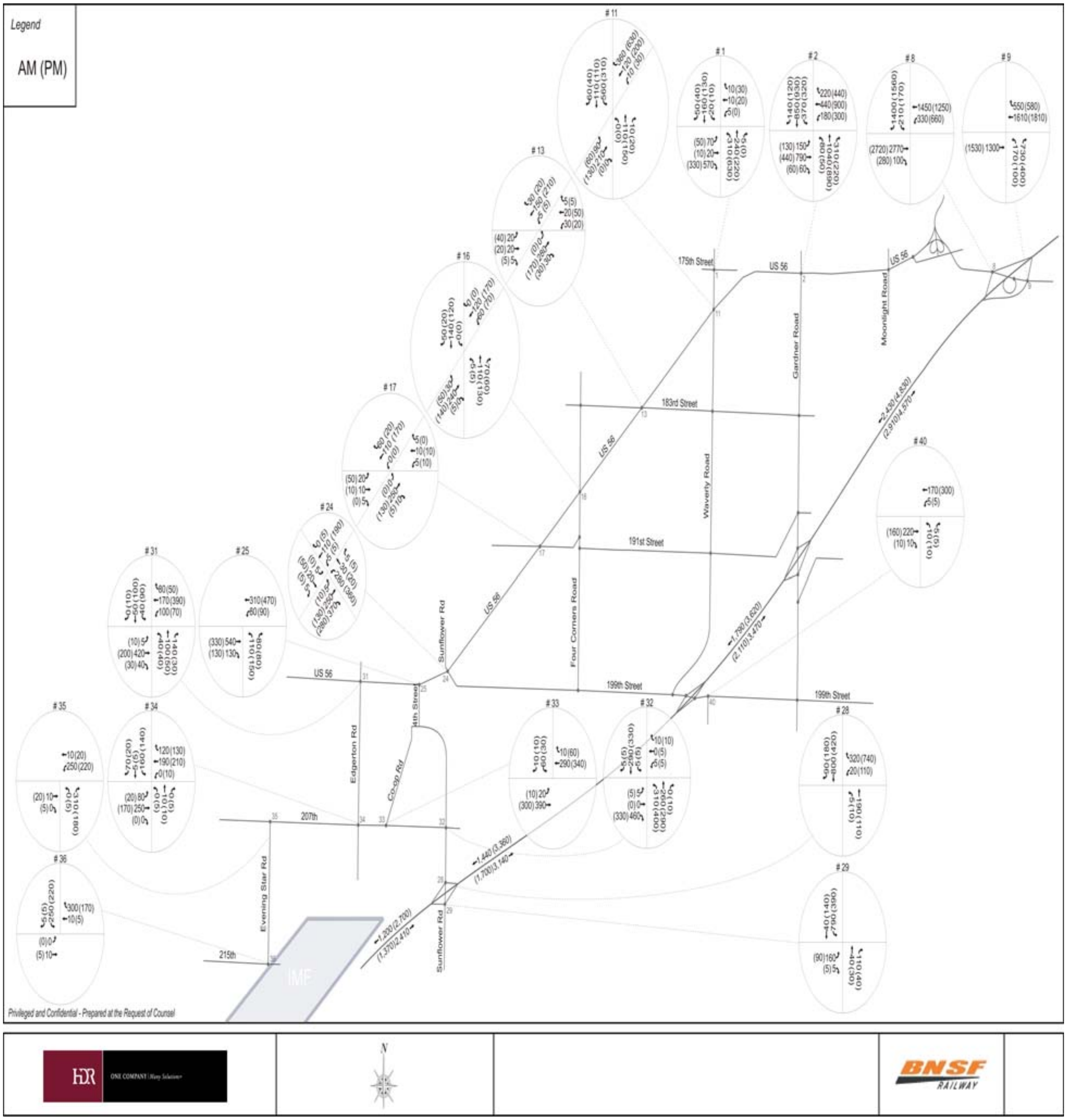


Figure 3-37: 2030 Wellsville North Alternative ADTs

<u>2030 Wellsville North Alternative Geometry Assumptions</u>

In addition to the improvements included in the 2030 Gardner No Action scenario, the Wellsville North Alternative roadway network geometry assumptions include a number of enhancements to attempt to provide sufficient capacity for the projected 2030 Wellsville North Alternative traffic. This includes signalization of both I-35/Sunflower Road ramps (Intersections #28 and 29) and conversion of intersection #31 (199th Street/Edgerton Road) to all-way stop control (all part of the No Action Scenario), in addition to upgrades to Evening Star Road and 207th Street to provide needed pavement sections and widths to support IMF truck traffic.

Figure 3-38: 2030 Wellsville North Alternative Turning Movement Volumes



2030 Wellsville North Alternative Intersection Analysis

The results of the 2030 Wellsville North Alternative intersection analysis are shown in Table 3-37. Intersections #8 and #32 were predicted to operate at unsatisfactory levels under the No Action scenario and would also operate at unsatisfactory LOS F with the Wellsville North Alternative. Intersection #8 (I-35 Southbound Ramps/US 56) is projected to operate at LOS F during both peak hours. Given that the forecasted delay increases are modest, this condition could be improved to acceptable levels by improvements needed with the No Action scenario. The eastbound and westbound approaches at Intersection #32 (207^{th} Street/Sunflower Road) are also forecasted to operate at LOS F during both peak hours. As with the No Action scenario, the failing left turn movements are too small (five vehicles or less) to be considered a significant impact of the project.

As Table 3-37 indicates, four other study intersections are forecasted to operate unacceptably under this scenario:

- *Intersection #28 (I-35 Southbound Ramps/Sunflower Road)*: This intersection is projected to operate at LOS F during the p.m. peak hour.
- *Intersection #29 (I-35 Northbound Ramps/Sunflower Road):* This intersection is projected to operate at LOS F during the a.m. peak hour.
- *Intersection #34 (207^{th} Street/Edgerton Road):* This intersection is forecasted to operate at LOS E during the a.m. peak hour.
- *Intersection #36 (215^{th} Street/Evening Star Road):* The southbound approach is forecasted to operate at LOS E during the a.m. peak hour. Reconfiguring the intersection to make this a free movement would eliminate the operational issue.

Impacts to Intersection #28 and Intersection #29 would be considered significant should they occur as they are located on state or major routes. Potential mitigation measures are discussed in the *Mitigation Technical Report* (HDR, 2008c). However, impacts to Intersection #34 and Intersection #36 would be considered moderate should they occur, and would not require project-related mitigation.

Table 3-37: 2030 Wellsville North Improved No Action and Alternative Study Intersection Analysis

			Improved No Action				Wellsville North Alternative			
			AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
	Location	Traffic Control	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
1	175th St/ Waverly Rd	Signalized	19.0	B	15.4	B	18.8	B	14.8	B
2	US 56/ Gardner Rd	Signalized	29.1	C	27.2	C	29.6	C	31.6	C
8	I-35 SB Ramps/ US 56	Signalized	119.3	F	184.3	F	120.2	F	186.5	F
9	I-35 NB Ramps/ US 56	Signalized	21.0	C	12.5	B	21.1	C	12.9	B
11	US 56/ Waverly Rd	Signalized	25.8	C	34.0	C	25.8	C	35.2	D
13	183rd St/ US 56	TWSC	12.4 (WB)	B	13.4 (EB)	B	13.6 (WB)	B	13.6 (EB)	B
16	US 56/ Four Corners Rd	TWSC	15.8 (SB)	C	18.2 (NB)	C	18.1 (SB)	C	18.8 (NB)	C
17	191st St/ US 56	TWSC	11.0 (EB)	B	11.4 (EB)	B	11.9 (EB)	B	11.6 (EB)	B
24	US 56/ Sunflower Rd	Signalized	19.0	B	19.3	B	23.7	C	24.1	C
25	US 56/ E 4th St	Signalized	10.9	B	11.7	B	13.6	B	11.6	B
28	I-35 SB Ramps/Sunflower Rd	Signalized	9.4	A	25.9	C	17.1	B	150.7	F
29	I-35 NB Ramps/Sunflower Rd	Signalized	14.4	B	8.9	A	87.9	F	13.1	B
31	199th & Edgerton	AWSC	18.2	C	21.6	C	27.0	D	24.1	C
32	207th & Sunflower	TWSC	28.7 (WB)	D	39.7 (WB)	E	80.9 (EB)	F	908.5 (WB)	F
33	207th & Co-op Road	OWSC	12.3 (SB)	B	11.7 (SB)	B	23.0 (SB)	C	18.2 (SB)	C
34	207th & Edgerton	AWSC	9.2	A	9.0	A	48.8	E	32.2	D
35	207th & Evening Star	OWSC	8.4 (NB)	A	8.8 (NB)	A	16.6 (NB)	C	14.4 (NB)	B
36	215th & Evening Star	OWSC	8.5 (SB)	A	8.5 (SB)	A	41.6 (SB)	E	23.4 (SB)	C

Notes: TWSC – Two-way STOP control, OWSC – One-way STOP control, AWSC – All-way STOP control, LOS – Level of Service.
Bold indicates a LOS below the acceptable threshold.
For one and two-way STOP-controlled intersections the delay and LOS for the worst approach is shown.

2030 Wellsville North Alternative Freeway/Ramp Analysis

The resulting analysis (for both mainline and ramp junctions) is summarized in Table 3-38. As the table indicates, all locations are forecasted to operate at an acceptable LOS of D or better during both peak hours. Therefore, only minor impacts are anticipated.

Table 3-38: 2030 Wellsville North Alternative Freeway/Ramp Analysis

		AM Peak Hour		PM Peak Hour	
Location	Lanes	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS
Basic Freeway Segments					
I-35 NB					
Edgerton to Sunflower	2	20.0	C	12.1	B
Sunflower to Waverly	2	27.5	D	13.5	B
Waverly to Gardner	3	19.4	C	12.3	B
Gardner to US 56	3	25.9	C	16.7	B
I-35 SB					
US 56 to Gardner	3	14.0	B	28.5	D
Gardner to Waverly	3	10.4	A	20.6	C
Waverly to Sunflower	2	12.8	B	31.2	D
Sunflower to Edgerton	2	10.5	A	23.0	C
Ramp Merge/Diverge					
I-35 NB					
Sunflower Road Off	N/A	21.1	C	11.6	B
Sunflower Road On	N/A	30.2	D	16.2	B
Waverly Road Off	N/A	28.9	D	13.3	B
Waverly Road On	N/A	21.3	C	13.1	B
Gardner Road Off	N/A	20.8	C	13.0	B
Gardner Road On	N/A	30.0	D	20.1	C
I-35 SB					
Gardner Road Off	N/A	16.3	B	30.6	D
Gardner Road On	N/A	11.1	B	21.7	C
Waverly Road Off	N/A	11.3	B	22.4	C
Waverly Road On	N/A	14.0	B	31.5	D
Sunflower Road Off	N/A	12.5	B	31.7	D
Sunflower Road On	N/A	12.1	B	25.6	C

Notes: pc/mi/ln – passenger cars per mile per lane, LOS – Level of Service.

3.5.5 Transit

<u>No Action</u>
In the No Action scenario, no new transit service is expected to be provided to the Wellsville North Alternative project site in either the short or long-term. However, the Regional Transit Plan (Smart Moves) includes long-term plans for extending-peak period bus service to the City of Edgerton.

<u>Wellsville North Alternative</u>
As with the Gardner project site, two types of potential transit service impacts are evaluated here: 1) increased demands on existing or planned service; and 2) demands for new service to serve the Wellsville North Alternative.

None of the employees are expected to use bus transit service on opening day as there is currently no transit service in the vicinity of the site. In the future, if the transit plans envisioned for the area are implemented, the peak-period service would extend south on US 56 to Edgerton, but it would be unlikely to serve the intermodal site directly. It may also have limited (or no) frequency, especially during the off-peak intermodal shift-change periods.

As described for the Proposed Action, the demand on any transit service related to an intermodal site associated with the Wellsville North Alternative is expected to be minimal. One reason for this is that the off-peak, two-shift/three-shift nature of the work would make using transit for both trip ends difficult. For example, approximately 80 percent of the employees are expected to work a 12-hour two-shift schedule with employees either starting or ending a shift at 7:00 p.m., a time period that typically has low-frequency bus service in low-density areas. In addition, the lack of regional service coinciding with the shift-change peaks would make it impractical for many employees to use transit.

In addition to the issues of shift-change schedules, bus routes/frequencies, and stop locations, there is the larger issue of overall demand and the provision of bus service to a low-density employment site. The intermodal site would have a low employment density with approximately 70 local employees on site during any one shift in 2010 (135 in 2030). This would result in an employment density of approximately one employee per 7.0 acres in 2010 and one employee per 3.5 acres in 2030. These employment densities are not typically consistent with the provision of regular scheduled bus service. In fact, service to these types of sites can have considerable cost, travel time, and delay implications for the service provider and other riders.

Therefore, as outlined above, no impacts are expected to the current or proposed transit service due to increased demand and no significant demand for new bus service is anticipated.

3.5.6 Pedestrian/Bicycle

<u>No Action</u>
In the No Action scenario, there are no major known planned changes to the pedestrian and bicycle facilities in the vicinity of the Wellsville North project site (including sidewalks, trails, or bike routes/paths).

<u>Wellsville North Alternative</u>
As with the Gardner project site, in the near term, pedestrian traffic to and from the Wellsville North Alternative project site is expected to be minimal. The primary reason for this is the long walk distances between the site and most residential or retail destinations. The nearest subdivision entrance is over two miles from the main gate. Second, as outlined previously, the number of on-site employees would be modest (under 70 on opening day and approximately 135 in 2030). A third reason is the off-peak two-shift/three-shift nature of the work. As mentioned in the transit section, approximately 80 percent of the on-site employees would work 12-hour shifts

with shift changes at 7:00 a.m. and 7:00 p.m. This would mean that employees would have to walk after dark during a portion of the year.

Pedestrian activity may increase in the future if new development would occur within walking distance of the project, but given the number of employees and the nature and dispersion of the on-site activity, it is not expected to be a major mode of transportation related to a project at the site. The pedestrian activity resulting from the Wellsville North Alternative could be accommodated on the 8-foot shoulders that would be included in the upgrades to Evening Star Road and 207th Street. The provision of paved shoulders (8-foot minimum) is considered important given the volume of truck traffic forecasted for these roadways.

Bicycle activity is expected to be minimal for the same reasons that pedestrian activity is expected to be minimal. Special provision of bicycle routes or lanes is not typically necessary for this type of land use. Any bicycle activity associated with the facility would be adult work-based trips and these trips could be accommodated on the planned paved roadways.

Regarding the impact on the existing and proposed facilities, there are no existing or future pedestrian or bicycle facilities that would be physically impacted by the Wellsville North Alternative.

3.5.7 At-Grade Rail-Highway Crossings and Delay

<u>No Action</u>
In the No Action Scenario, train volumes and lengths would continue to increase over time, leading to increased blocked times[3] and increased vehicular delay at all of the at-grade highway-rail crossing locations. The blocked times and delay are expected to be similar to those presented previously in the Gardner No Action scenario.

<u>Wellsville North Alternative</u>
With the Wellsville North Alternative, there would have to be a number of changes to the current at-grade crossings in the area (see Figure 2-14). They include from south to north:

- *Main Street in Wellsville* – Grade-Separated
- *223rd Street* – Grade-Separated
- *215th Street* – Closed
- *Edgerton Road* – Grade-Separated
- *207th Street* – Grade-Separated
- *E. Nelson Street* – At-Grade
- *199th Street* – At-Grade

Thus, in the Wellsville North Alternative scenario, a total of five at-grade crossings would be eliminated through grade separation or closure. The remaining two at-grade crossings would experience increased blocked time and delay. However, similar to the situation at Moonlight Road in the Proposed Action scenario, these two locations would actually have fewer trains than in the No Action scenario because they are located north of the site. While the maximum delay time would likely increase as was shown for the Proposed Action, it is not expected that the total increase in average blocked time and delay would be significant (in fact, it could decrease). Therefore, no significant impacts are predicted.

[3] Blocked time includes both the train occupancy time and the time of the flashing light or gate down.

3.5.8 Emergency Vehicle Access

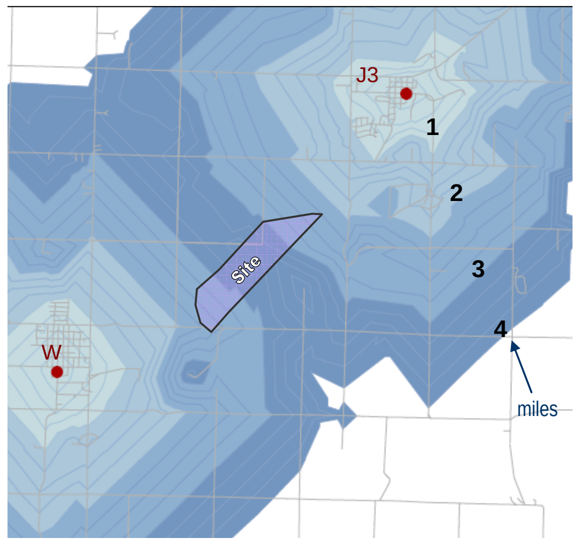
No Action

In the No Action Scenario, emergency vehicle access routing and distances are expected to remain as outlined in Section 2.2.7 (Figure 2-15). However, two future changes would affect emergency vehicle access: the volume of train traffic is expected to increase over time and the average length of those trains is expected to increase. This would increase the potential for delay (and longer delays) when responding vehicles must cross railroad tracks.

Wellsville North Alternative

The construction of an IMF at Wellsville North would result in changes to the local roadway network, but these changes are not expected to negatively impact emergency vehicle response distances from either the Wellsville (W) or Edgerton (J3) station locations. The main changes would be increased reliability of travel times due to additional grade separations in the area. For this site, the only anticipated road closure would be along 215th Street between Evening Star Road and Edgerton Road. As the road network in this area is a grid system, there are other roads that can be used instead of this road, with little or no effect on travel distance. Figure 3-39 shows the emergency vehicle response distances for both stations with the closed portion of 215th Street eliminated. There is essentially no difference between these response distances and the No Action response distances.

Figure 3-39:
Distance from Emergency Response



With the new grade separations, both stations could serve either side of the BNSF mainline without crossing rail lines at-grade, and emergency vehicle response impacts would be considered minor.

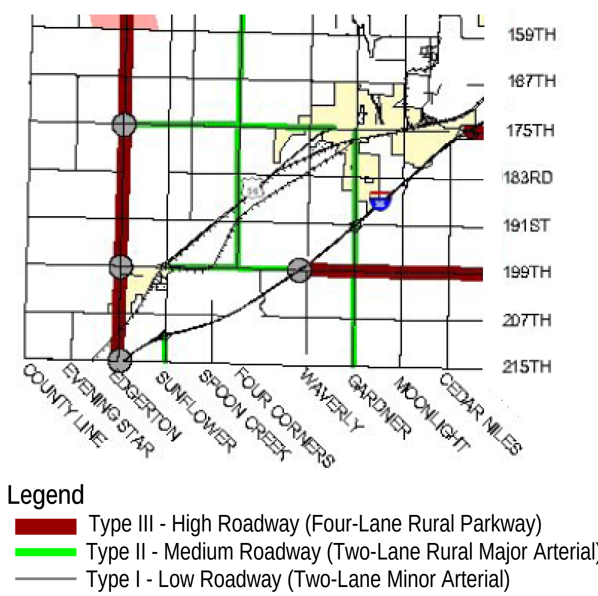
3.5.9 Circulation System

No Action

In the No Action Scenario, the local and regional connectivity in the vicinity of the Wellsville North Alternative would remain similar to what it is today, with a few exceptions. The exceptions include the following:

1. Development will continue in the area. This will include more dense development in the areas with water and sewer service.
2. Railroad traffic will continue to increase (as outlined previously), leading to increased potential for delay at mainline railroad crossings.

Figure 3-40:
Johnson County CARNP – Wellsville Area



There are no major new highways or interchanges currently planned or funded in the immediate vicinity of the Wellsville North project site that have been deemed reasonably foreseeable. However, the Johnson County CARNP shows a new grade-separated access point on I-35 at Edgerton Road (refer to Figure 3-40). This would improve regional connectivity in the long-term if implemented. The CARNP also shows upgrades to Edgerton Road (to the north) and Sunflower Road (to the south). Specifically, Edgerton Road is shown as a four-lane rural parkway (Type III – High Roadway) north of I-35. South of I-35, Sunflower Road is proposed as a two-lane rural major arterial (Type II – Medium Roadway). 207th Street and Sunflower Road north of I-35 are shown as two-lane minor arterials (Type I – Low Roadway).

Overall, few reasonably foreseeable major changes to the local circulation patterns are expected in the vicinity of the Wellsville North project site, though the existing local highways may be improved to provide enhancements to existing connections.

<u>Wellsville North Alternative</u>
With the Wellsville North Alternative, the circulation in the vicinity of the site would be changed somewhat due to the closure of 215th Street (between Evening Star Road and Edgerton Road). However, given the current (and expected future) low traffic volume on this section of roadway – the 2005 ADT was approximately 30 vehicles – this closure is not anticipated to substantially change local circulation and connectivity. It was also assumed that roadways west of the Wellsville North Alternative site (such as 215th Street west of Evening Star Road) would remain gravel and would not be available for commercial truck use.

3.5.10 Roadway Design Considerations

<u>No Action</u>
In the No Action Scenario, the highway system could be expected to continue to evolve in a manner consistent with past trends. This would include periodic roadway upgrades as needed, that meet the then current state and local roadway design standards. Some of these improvements may be initiated by public agencies and some by private developments. In the immediate vicinity of the IMF, there are few currently planned highway design improvements. As outlined under *Circulation System* above, long-term improvements are being considered for Edgerton Road including a possible new interchange on I-35.

<u>Wellsville North Alternative and Future IMF Operations</u>
With the Wellsville North Alternative, a number of the local roads would need to be upgraded. This would likely include upgrades to Evening Star Road, 207th Street, and Sunflower Road; also, 207th Street would include grade-separated crossings over the BNSF tracks. These roads would be designed to meet applicable state and local standard and, including pavement depth and type appropriate for the projected auto and truck traffic. In all Wellsville North Scenarios (2010, 2015, and 2030), the vast majority of IMF trucks are forecasted to use these roadways to travel to and from I-35. Therefore, roadway design issues related to the project would be minimal for these scenarios.

3.5.11 Construction Traffic

Construction of the Wellsville North Alternative, including related infrastructure, would occur over a period of 18 to 22 months. Major road and bridge construction would potentially be completed in the first 12 months. Construction staging areas would mainly be on site, though some off-site areas may be used related to the roadway and bridge construction. Access to all homes and properties along the affected roadways would be maintained during construction and is considered a minor impact.

Construction could affect local residents due to short-term or partial road and railroad crossing closures as well as the effects of construction traffic to and from the site. Major access to the Wellsville North site during construction would likely be the same as during normal operations.

Therefore, any traffic impacts would likely be along the same access corridor of Sunflower Road, 207th Street, and Evening Star Road. The primary expected types of traffic include construction employee traffic, equipment/supply traffic, and material hauling traffic. However, it is not currently known how much construction traffic in each category would be generated by the Wellsville North Alternative. A traffic management plan should be developed in conjunction with the local communities and counties as part of the development of construction phasing and implementation plans.

3.6 Indirect Effects – Future Wellsville North IMF Operations plus Induced Development

It is unclear what or how much new traffic-generating development would be induced if the Wellsville North Alternative were implemented. There are no current plans to develop a warehousing facility in the vicinity of the Wellsville North Alternative. However, if an IMF were sited at Wellsville North, it is likely that a certain amount of warehousing or other industrial development would be induced by the IMF operation. It is also possible that an IMF sited in the Wellsville North development area could induce commercial land use, such as convenience stores, gas stations, and restaurants; however, no information exists as to the nature and location of such development. Given this uncertainty, it is difficult to project specific future traffic flows or impacts. This applies to intersection/roadway capacity, freeway facility capacity, and also general roadway circulation and access.

The amount of induced development in the area surrounding the Wellsville North Alternative cannot be quantified. However, it is reasonable to conclude that any substantial induced development in this area could cause some of the low-capacity rural intersections and roadways in the area to need further improvements. This could include improvements to the I-35/Sunflower Road interchange and additional improvements along 207th Street.

In addition, because the induced development surrounding the Wellsville North Alternative cannot be quantified, it is not possible to quantitatively assess indirect effects in the areas of transit use or service, pedestrian/bicycle activity or facilities, at-grade rail-crossing volumes or delay, or emergency vehicle access. Even qualitative assessments would be speculative without some level of information regarding the type, size, and location of induced development.

4.0 POTENTIAL MITIGATION MEASURES

4.1 Gardner

Mitigation measures are discussed in the *Mitigation Technical Report* (HDR, 2008c).

4.2 Wellsville North

Mitigation measures are discussed in the *Mitigation Technical Report* (HDR, 2008c).

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APPENDICES

Appendix A:
Methodology

Appendix A - Methodology

The traffic analysis methodology employed for this study is based on widely accepted traffic engineering approaches and procedures. The methodology was presented to Federal, state and local agency staff for their review and concurrence. One methodology presentation was given on November 30, 2007. A second presentation (highlighting the additional analysis for the Wellsville North Alternative) was given on February 8, 2008. In addition to these NEPA methodology presentations, there were many methodology meetings and discussions that preceded the current NEPA traffic analysis. These discussions took place over the course of the previous 16 months in conjunction with the *I-35 Break-In-Access Study near Gardner, KS*. During these meetings, a variety of traffic forecasting and analysis methods were presented, discussed, and agreed upon. Some of these applied directly to the NEPA analysis work that followed.

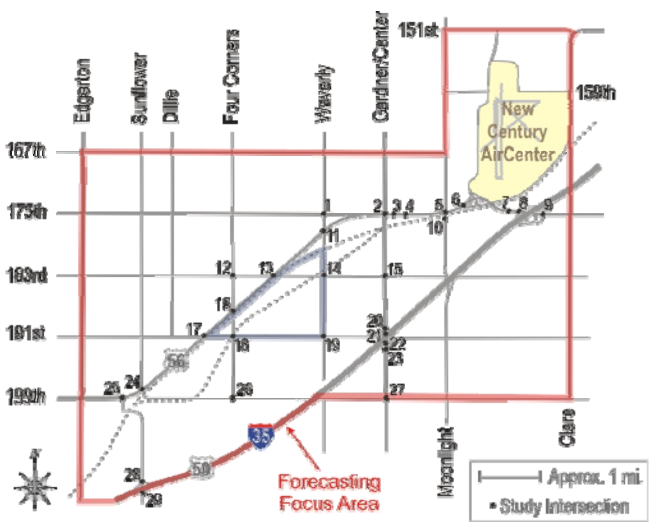
This appendix provides a summary of key study methodologies in six main topical areas:

1. Study Area and Study Facility Identification
2. No Action Traffic Forecasts
3. Gardner Proposed Action and Future Gardner IMF Operations Traffic Forecasts
4. Gardner IMF Operations + Induced Development Traffic Forecasts
5. Wellsville North Alternative Traffic Forecasts
6. Traffic Operations Analysis Methods

Study Area and Study Facility Identification

In late 2006 / early 2007 a Traffic Forecasting Focus Area was defined as part of the *I-35 Break-in-Access Study* (BIA). This Focus Area was set through a consensus process that involved the critical Federal, state, and local agencies. The Traffic Forecasting Focus Area is shown in Figure A1. It was determined that this Focus Area addressed an area more than adequate for capturing the potential NEPA traffic impacts of the Proposed Action. Therefore, this proposed Gardner traffic study area and a set of specific highway facilities within the study area were presented to the agencies and received their concurrence for inclusion in the NEPA traffic analysis methodology.

Figure A1: I-35 BIA Traffic Forecasting Focus Area

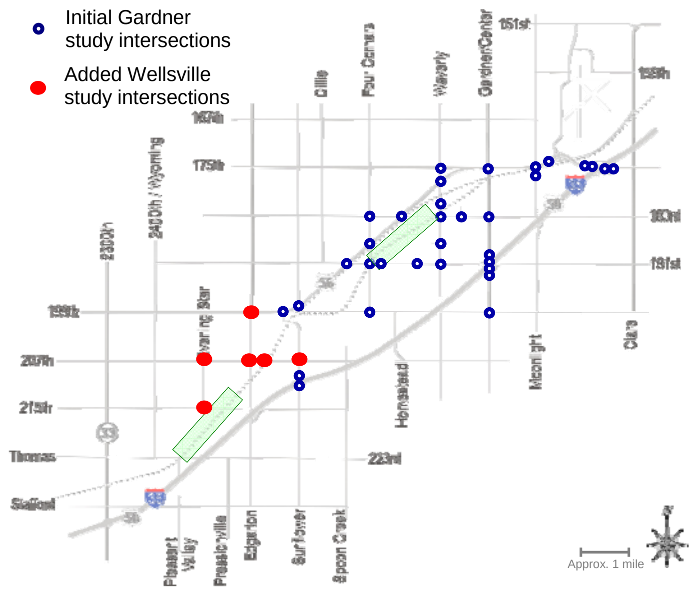


The facilities addressed in the analysis included critical intersections, freeway ramps, and freeway mainline sections in the Gardner traffic study area as displayed in the body of the report. The study intersections included major intersections along arterials and collectors that could be impacted by the proposed project (e.g. US 56, Gardner Road, and 199th Street) as well as some more remote intersections that were deemed important. The only adjustment made to the study facilities between the BIA meetings and the NEPA documentation was that the Sunflower Interchange and freeway segments to the south were not studied in the Gardner scenarios because they were found to attract an inconsequential amount of traffic from the Gardner IMF.

For the Wellsville North Alternative, the Edgerton vicinity was added to the prior Gardner traffic study area. This new area and the added intersections were shown to the resource agencies at the February 2008 methodology meeting (see Figure A2). To determine which of the intersections included in the Gardner Area should be included in the Wellsville North analysis, a threshold of 10 peak-hour project trips and a two percent increase in peak hour traffic (by movement) was applied to each intersection. Intersections that did not meet this minimum threshold during at least one peak hour were not examined in detail for capacity purposes. Again, the actual study intersections, ramps, and freeway sections are presented in the body of the report.

No Action Forecasts

Figure A2: Wellsville Alternative Site Vicinity and Study Intersections



Existing Volumes

Existing traffic volumes were developed based on recent daily and peak-period count data as outlined in the body of the report. The count data was smoothed to provide balance between various study intersections and freeway facilities. Truck volumes were also estimated based on the available truck counts in the Gardner and Wellsville North study areas. These existing (2008) traffic volumes provided the basis for the 2010 and 2015 No Action forecasts.

2010 / 2015 No Action Forecasts (Both Study Areas)

The 2010 and 2015 No Action traffic forecasts for both the Gardner and Wellsville North study areas were developed using growth rates and applying them to the baseline 2008 volumes. Traffic growth rates were originally investigated during the I-35 BIA study process. Further investigation of historical KDOT count data during the NEPA traffic analysis work confirmed the use of 2.8 percent as the near-term compounding growth rate for local, collector, and arterial roadways in both the Gardner and Wellsville North areas. A near-term rate of approximately 3.2 percent was employed for I-35. These growth rates were applied to all study intersections and highway links. Traffic volumes were balanced between various intersection and freeway facilities taking into account access and development intensity considerations. Additional adjustments were made when dictated by a specific condition such as the re-alignment of 191st Street to connect to Gardner Road at 188th Street or a specifically known approved development such as the Sunflower Ridge Subdivision in Edgerton.

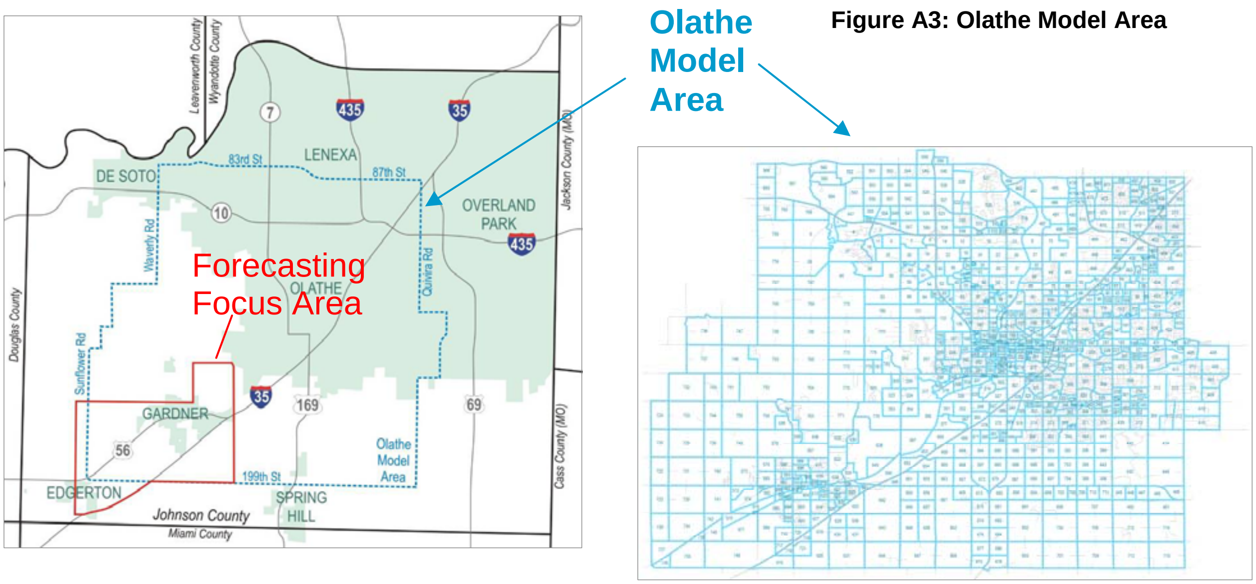
2030 No Action Forecasts (Gardner Area Only)

To develop the long-term 2030 traffic forecasts for the Gardner study area, a very different approach was employed. For these forecasts, the City of Olathe's computerized travel demand forecasting model was selected as the most appropriate platform. The original model provided by the City of Olathe for this analysis covered the majority of the study area and included land-use forecasts for 2010, 2015, and 2050. The use of this model for projecting traffic in the Gardner area was initially presented to the appropriate Federal, state, and local agencies during the I-35 BIA study process. They agreed that it was the best available method for developing long range forecasts for this area. Therefore, in partnership with the agencies, a set of 2030 land-use and transportation network assumptions were developed for the Traffic Forecasting Focus Area. These assumptions formed the basis of the 2030 No Action model runs for the current NEPA analysis. A summary discussion of the model, key assumptions, and other related topics is presented in this document. Additional details especially regarding No Action land-uses and the treatment of model external stations are included in the I-35 BIA report and appendices.

Forecasting Model

The Olathe Travel Demand Model (OTM) uses the TransCAD modeling software to forecast daily and p.m. peak hour forecasts for a typical weekday. The OTM covers an area about 14 miles long (north-south) and 15 miles wide (east-west). The approximate model limits are 87th Street/83rd Street to the north, Quivira Road to the east, 199th Street to the south, and Sunflower Road to the west. The model boundary is illustrated in Figure A3. The OTM divides the region into 782 internal Traffic Analysis Zones (TAZs), which allow existing and future land-use/socioeconomic information to be grouped into reasonably sized areas. These TAZs are joined to the transportation network by links known as centroid connectors, and the OTM - through an iterative process - generates, distributes, and assigns traffic to the transportation network. In addition to the 782 internal TAZs, the OTM includes 72 external zones that represent traffic heading in and out of the model (such as I-35 south of 191st Street).

Figure A3: Olathe Model Area



Land-Use Forecasts

The Traffic Study Corridor is at the southwestern edge of the Olathe model; in fact, the Sunflower Interchange is outside the OTM. Much of the area within and near the Traffic Study Corridor is in a state of flux regarding future land-use and transportation planning; therefore, to prepare the OTM for the needed analysis, the 2030 land-use and network assumptions were reviewed and refined. Refining these assumptions involved extensive input from multiple agencies (Agencies), including the Kansas Department of Transportation (KDOT), the Federal Highway Administration (FHWA), the City of Gardner, the City of Edgerton, the City of Olathe, Johnson County, Miami County, and the Mid-America Regional Council (MARC). Through an extensive, collaborative process, these agencies reached consensus regarding the 2030 land-use and network assumptions to be included in the OTM.

The original Olathe model included four horizon years: 2004 (existing), 2010, 2015, and 2050. Since 2030 was identified by the Agencies as the desirable long-term year for traffic forecasting and impact analysis, a new set of land-use assumptions had to be developed for this model horizon year. The process for creating the approved 2030 land-use inputs included (1) Linear interpolation between the OTM's 2015 and 2050 land-use scenarios, (2) Specific inputs by the City of Gardner related to future growth within and near the City, and (3) extensive review and input from the remaining Agencies, especially Johnson County and the City of Edgerton. The process also included manipulation of the OTM's external link volumes to represent relevant expected growth beyond the OTM edges (such as redevelopment of the Sunflower Army Ammunition Plant site).

In addition to the agency coordination described above, several comprehensive planning, land use, and zoning documents were obtained and reviewed to identify future land-use and transportation plans/assumptions within or near the Traffic Study Corridor that might affect the 2030 No Action Scenario. The following documents and studies were considered:

- Miami County - *Comprehensive Plan*, September 2004
- Johnson County – *Comprehensive Arterial Road Network Plan (CARNP)*, January 1998
- Johnson County – *The Rural Comprehensive Plan*, June 2004
- Johnson County - *Sunflower Army Ammunition Plan Conceptual Land Use Plan*, June 1998
- Johnson County Planning Commission - *New Century AirCenter Comprehensive Compatibility Plan*, February 1996
- Johnson County & Tetra Tech EM, Inc. - *Sunflower Army Ammunition Plant Supplemental Environmental Assessment,* January 2004
- City of Olathe - *2005 Transportation Study*
- Gould Evans Goodman Associates - *Lone Elm Vicinity Plan* and Draft Update, June 2000 and February 2007
- City of Edgerton - *Comprehensive Land Use Plan*, 2000

- City of Gardner - *Comprehensive Plan*, 2003
- KDOT - *K-10 Transportation Study*, May 2005
- KDOT & Johnson County – *K-10 Corridor Study Update*, January 2004
- KDOT (HNTB & HDR)- *K-7 Corridor Management Plan*, February 2006
- City of Olathe (HNTB) - *I-35 & Lone Elm Road Interchange Environmental Assessment*
- MARC - *South Metro Connector Study* (ongoing)
- KDOT (HDR) - *I-35 in Gardner, KS Break In Access Study*

The finalized land-use scenario included adjustments to account for known major developments and plans in the area including: Sunflower Army Ammunition Plant, Lone Elm Plan, development at New Century AirCenter, and other expected growth in Gardner. Further details regarding the approved land uses in the 2030 model are available in Appendix A of the I-35 BIA which includes the *Land-Use and Traffic Forecasting Assumptions Memorandum* (HDR, 2/2/07) and the September 2007 memo addendum.

Model Roadway Network

The model network was also updated to an anticipated 2030 condition. The process for creating the 2030 No Action model network was similar to the land-use update process, involving starting from the 2050 network as a base and working with the Agencies to gain consensus regarding appropriate additional modifications. Based on working with the Agencies, a number of additional improvements were included in the No Action Scenario. The major additional assumed improvements are illustrated in Figure A4 and key assumptions are listed below. (Some of the improvements listed below only affect the 2030 No Action capacity analysis and not the modeling, but they are included for context and reference.)

- *I-35 mainline* – It is assumed that I-35 will be widened to six lanes from 151st Street to a new interchange in the vicinity of 199th Street and Waverly Road.

- *I-35/Gardner Road interchange and vicinity* – The assumptions at this interchange include signalization of both ramp terminals, and the addition of right-turn lanes at the southbound ramp intersection (westbound and southbound approaches). It is further assumed that both 191st Street intersections with Gardner Road will be moved several hundred additional feet away from the interchange to provide adequate separation to facilitate traffic flow. On the north side, this would tie into the current 188th Street alignment west of Gardner Road (including intersection signalization).

- *I-35 / 199th Street & Waverly Rd. Interchange Constructed* – Based on input from KDOT, by 2030 a new interchange was assumed to be constructed on I-35. For modeling purposes, it was assumed that the interchange was consistent with the CARNP and was located near 199th Street and Waverly Road. The interchange concept used in the analysis was a simple diamond with ramps to 199th Street. Waverly Road was offset and was discontinuous to the north and south.

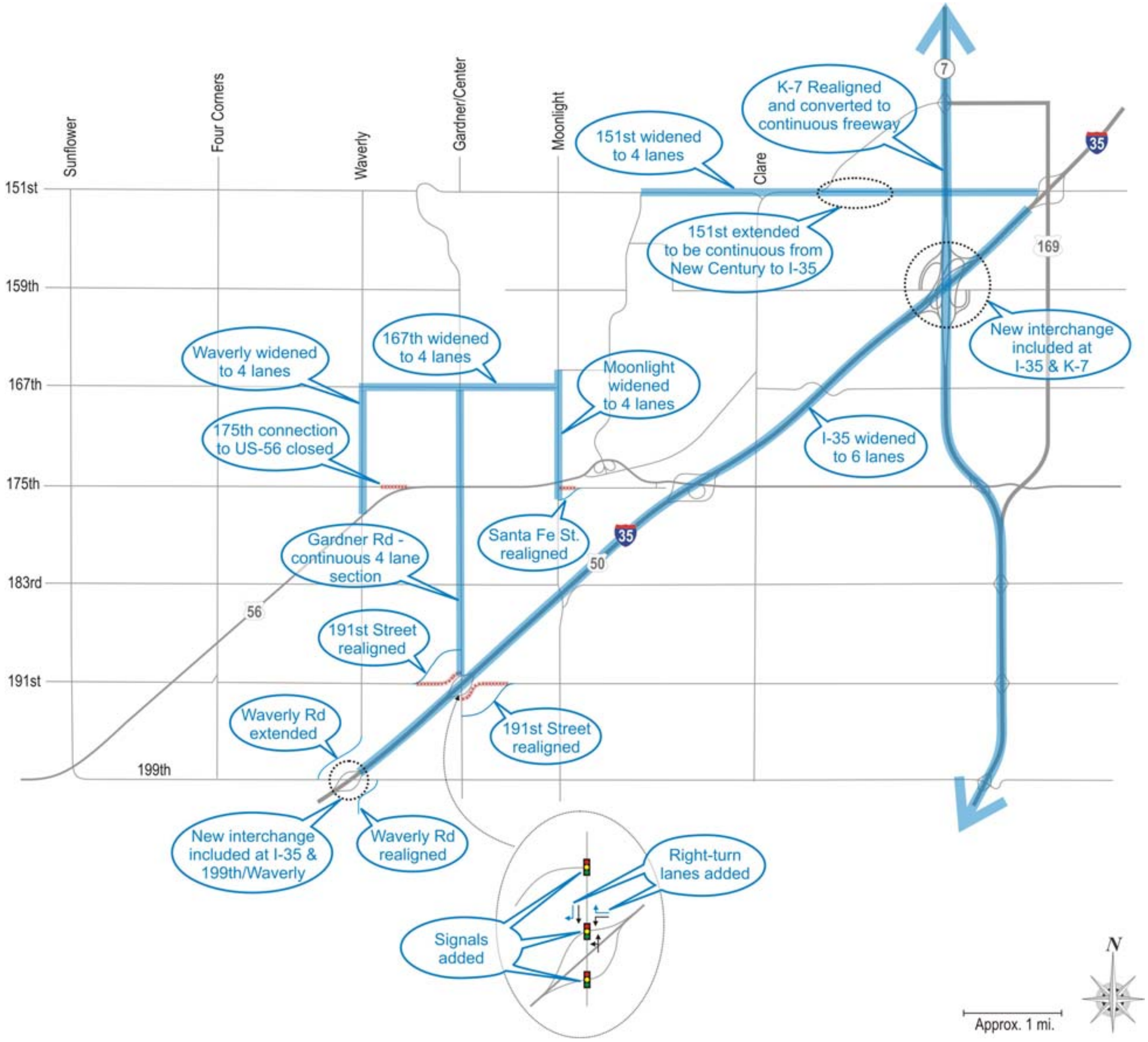
- *K-7* – In keeping with the recommendations of the *K-7 Corridor Management Plan,* the 2030 No Action scenario assumes that K-7 will be converted to a continuous freeway from Spring Hill north through Olathe. This includes a new freeway-to-freeway interchange with I-35 in Olathe. K-7 is not near Gardner, but it is in the OTM and heavily influences regional traffic volume distributions.

- *151st Street* – It is assumed in the 2030 model that 151st Street will be a four lane roadway from New Century Road east to I-35, continuing over the railroad tracks east of Old US 56 where it currently is discontinuous.

- *167th Street* – It is assumed that 167th Street will be widened from two to four lanes between Waverly Road and Moonlight Road.

- *175th Street* – The “triangle” created by 175th Street, US 56, and Waverly Road presents challenges for traffic operations and it will continue to do so as traffic volumes increase. The 2030 No Action scenario assumes that the 175th Street connection to US 56 will be closed so that motorists traveling between 175th Street and US 56 will need to use Waverly Road.

Figure A4: Anticipated Major Transportation Network Improvements in the Gardner area by 2030



- *Gardner Road* – Much of Gardner Road between US 56 and I-35 already consists of a four-lane cross-section, but there are several areas with only two lanes. The 2030 No Action scenario assumes a complete four-lane facility for this entire segment, including the widening of the bridge over the BNSF tracks.

- *Waverly Road* – It is assumed that Waverly Road will be widened to four lanes between US 56 and 167th Street.

- *Moonlight Road* - It is assumed that Moonlight Road will be widened to four lanes between Santa Fe Street and 167th Street, and that the Moonlight Road/Santa Fe Street intersection will be relocated approximately 600 feet south to provide better separation from the BNSF tracks and US 56.

- *Local Streets* – Some of the existing roads between US 56 and I-35 are currently low-volume gravel roadways, including Waverly Road, 191st Street, and 183rd Street. Johnson County's CARNP shows these roads as future paved facilities. The 2030 No Action model increases the capacities of these roadways to reflect the CARNP recommendations. Speeds on some of the local roads were also adjusted to better reflect expected 2030 conditions.

- *Intersection Upgrades* - Many of the study intersections, especially those along US 56, are assumed to be upgraded under the No Action scenario to attempt to provide sufficient capacity for the 2030 No Action volumes.

The OTM includes many other assumptions regarding future improvements for the entire area covered by the model. These underlying model assumptions were not changed as part of this project.

2030 Volumes
Using the above land-use and network assumptions the model was used to develop 2030 daily and p.m. peak hour traffic volumes in the Gardner area. The resulting "raw" model output was then post-processed to develop final volumes. This included calculating, and in many cases applying, the difference between the calibrated base model output and comparison traffic counts (both for links and intersections).[1] This helped ensure that localized traffic patterns were taken into account and that under- or over-representation of volumes were corrected. Existing truck traffic was also examined to develop balanced estimates of future truck volumes. (The OTM does not forecast trucks separately from non-trucks.) It was assumed that background truck growth was similar to the overall traffic growth on a daily basis, but that it grew at approximately 75 percent of that rate during the a.m. and p.m. peak hours. The final volumes were then reported in figures and used in the capacity analysis.

Because the Olathe model does not have an a.m. peak hour component, a process was developed to produce a.m. forecasts. This involved first comparing the a.m. and p.m. peak hour data in the Gardner area. This comparison revealed that the two data sets have definite reverse flow characteristics. Many key movements are heavy in one direction in the a.m. peak hour and in the reverse direction in the p.m. peak hour. It also revealed that the a.m. peak hour volumes were approximately 93 percent of the p.m. peak hour volumes overall. Therefore, the p.m. peak hour model trip matrix (origins and destinations) was transposed (flipped) and factored (by approximately 0.93) to develop an estimated a.m. trip matrix. This a.m. trip matrix was then assigned to the 2030 network to provide 2030 a.m. peak hour "raw" model output. Again, this data was adjusted based on a comparison of a base year a.m. model run (developed using the same process) and comparison traffic counts. Balanced truck volumes were also estimated.

The final volumes were determined to be representative of the anticipated 2030 No Action peak hour and daily traffic flows, based on the approved land use and network assumptions.

2030 No Action Forecasts (Wellsville North Area Only)
The 2030 No Action forecasts for links and intersections in the immediate Wellsville North area were developed in a manner more consistent with the 2010 and 2015 forecasts. This was necessary because the OTM boundary is Sunflower Road in the west and 199th Street in the south. Therefore, growth rates were used outside the model area to project a baseline traffic increase to 2030. Then additional adjustments were made to account for expected growth not included in these growth factors. This included traffic growth due to the Sunflower Army Ammunition Plant, the Sunflower Ridge Subdivision, and new residential growth in Miami County. Land-use planning documents and plans were again consulted in developing these No Action forecasts. The resulting volumes were balanced with the 2030 No Action volumes resulting from the model output for the Gardner area. Again, the final balanced volumes were presented in figures and used in the capacity analysis.

Gardner Proposed Action and Future Gardner IMF Operations Traffic Forecasts

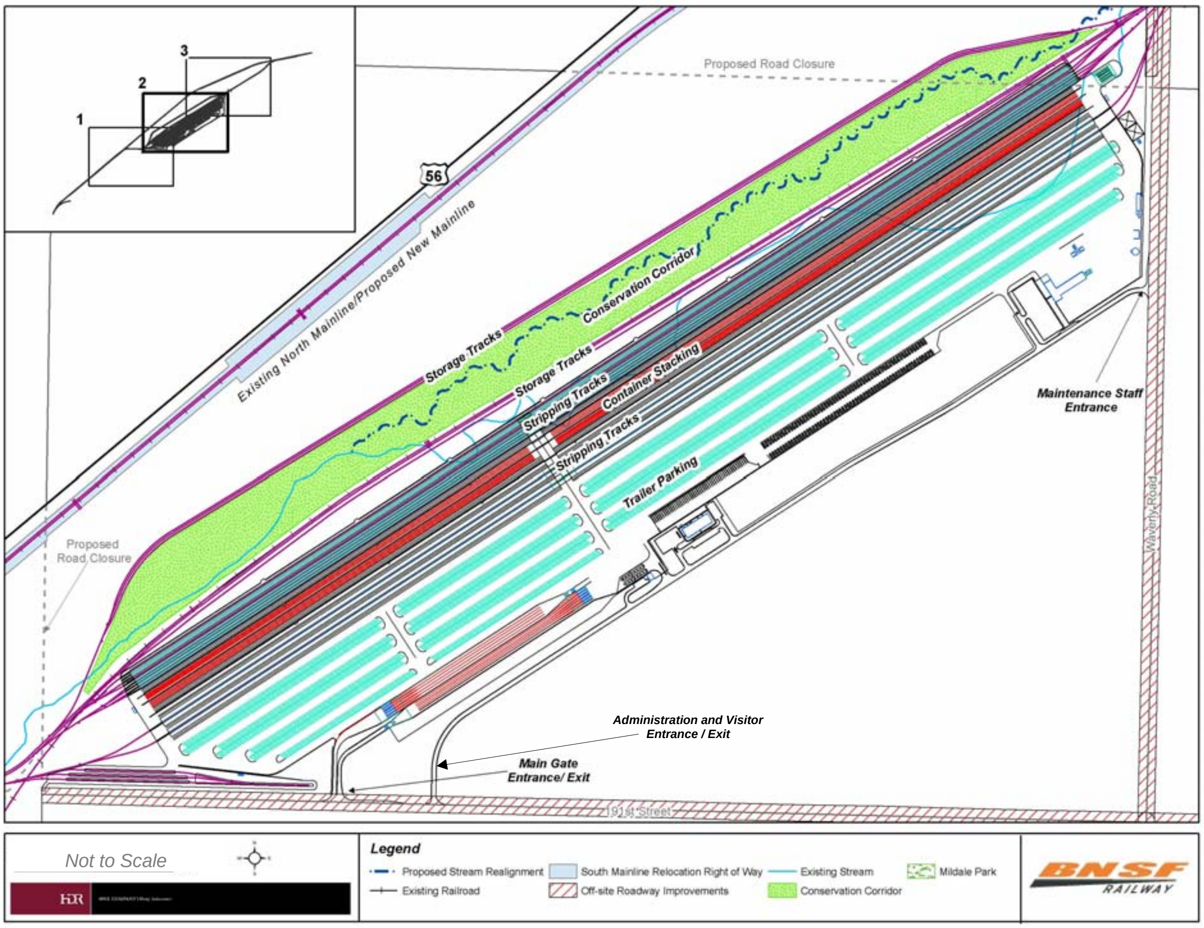
Proposed Action
The Proposed Action is discussed in detail in Chapters 1 and 2 of the Draft Environmental Report. For traffic forecasting purposes the main elements of the Proposed Action include:

- Construction of a highway-rail Intermodal Facility inside the area bounded by 191st Street, US 56, and Waverly Road as shown in Figure A5;
- Closure of 183rd Street between US 56 and Waverly Road (including two at-grade rail crossings);
- Closure of Four Corners Road between US 56 and 191st Street (including two at-grade rail crossings);

[1] For the few Gardner area intersections located outside of the model (in Edgerton) the methods described for the Wellsville North area analysis were used and the volumes were balanced to the nearest model intersection results.

- Closure of 191st Street between US 56 and Four Corners Road (including an existing at-grade rail crossing);
- Discontinued use of the existing at-grade rail crossing on 199th Street a little over half a mile west of Four Corners Road.
- Road improvements on 191st Street from Four Corners to Gardner Road (paved two-lanes and sidewalk on one side);
- Road Improvements on Waverly Road from 191st Street to US 56 (paved two-lanes);
- Grade separation of Waverly Road and the intermodal lead tracks, and
- Realignment of the southern BNSF mainline track to follow the northern track alignment between Gardner and Edgerton.

Figure A5: Proposed Action Site Plan



Key aspects of site operations and access that affect the traffic analysis include:

Truck Access: Inbound and outbound trucks using the Gardner IMF would primarily enter and exit via a common access point on 191st Street a little over a mile west of Waverly Road and about 2,000 feet east of the current intersection of 191st Street and Four Corners Road. Operations would be 24 hours a day. Incoming trucks would initially pass through an automated gate with an average processing time of 3 minutes. Once a truck has passed through the gate, it would be subject to additional internal processing. Multiple entry gates and on-site queueing storage would be provided to streamline processing and prevent queueing back onto the local street system.

Employee Access: Employee access to the intermodal site would be separate from the truck access for security and operational reasons. The main employee entrance would be on Waverly Road, approximately 1,500 feet south of 183rd Street. The visitor and administration entrance would be on 191st Street a short distance east of the truck entrance. All employee parking would be accommodated on site.

Train Volumes: BNSF anticipates that initially (in 2010) approximately six trains per day would access the Gardner IMF. By 2030, it is projected that this would increase to an average of approximately 13 trains per day.

Train Speeds: Average train speed data was provided by BNSF. Construction of the Gardner IMF is not expected to substantially affect the average mainline train speeds through the area. However, trains entering and departing the Gardner IMF may have slower speeds depending on location and direction.

Train Lengths: BNSF provided average train length data for both mainline trains and trains entering and departing the Gardner IMF. Average train lengths are forecasted to increase over time. For example, in the scenarios with the IMF, average mainline train lengths are expected to increase from 6,500 feet in 2010 to 7,400 feet in 2030, while the intermodal trains entering and departing the IMF are expected to increase from 6,850 feet in 2010 to 7,700 feet in 2030.

Gardner IMF Trip Generation

Trip generation represents the amount of traffic generated by a given project or site. For the Gardner IMF, two main variables were examined to calculate the trips generated by the project: employees and lifts. A lift is defined as the movement of a container either onto or off of a train. Table A1 presents the key variables and summarizes the daily and peak-hour trip generation rates and totals used for the proposed Gardner IMF for 2010, 2015, and 2030. The trip generation results are separated by trucks, bobtails, and non-trucks. Bobtails are trucks that are not pulling a trailer or chassis (i.e. cab only). They are separated out because they have different traffic operating characteristics than trucks with trailers.

The Gardner IMF truck trip generation is based on data derived from BNSF's existing Argentine Intermodal Facility in Kansas City, Kansas. It is anticipated that the intermodal component of the Argentine facility will be replaced by the activity in Gardner; therefore, the Argentine facility is considered to be a suitable model for the trip generation characteristics of the proposed facility. There are other intermodal facilities in the U.S. that could be comparable, but given their locations and the types of markets they serve (which differ from the market served by Kansas City intermodal traffic), they were not considered to be as representative as the Argentine facility.

Based on correlations between the reported lifts and truck trips at the existing Argentine Yard, factors were developed to convert annual lifts to daily and peak-hour truck volumes for the proposed Gardner IMF. To develop these factors, three months of in-out gate data was considered. During this three-month period, 98,809 trucks with trailers were logged either entering or leaving the yard. Bobtails use a separate gate and are not logged. A matching analysis was conducted on the reported gate data and it was determined that approximately 28 percent of these in and out truck trips matched during a rolling one hour period as illustrated in Table A2.[2] The remaining trips (72 percent) were therefore assumed to have bobtails serving the other (unreported) end of the trip. (Source: BNSF and Environ Consulting, 2007.) This resulted in 169,486 one-way truck trips (trucks and bobtails) for the three-month period or an estimated 677,944 one-way trips for the year. Of these total one-way trips it was assumed that 59.3 percent were truck-trailer trips (loaded, unloaded, and bare chassis) and 41.7 percent were bobtails.

Table A2: Three Months of Logged Matches at Argentine Yard Gate

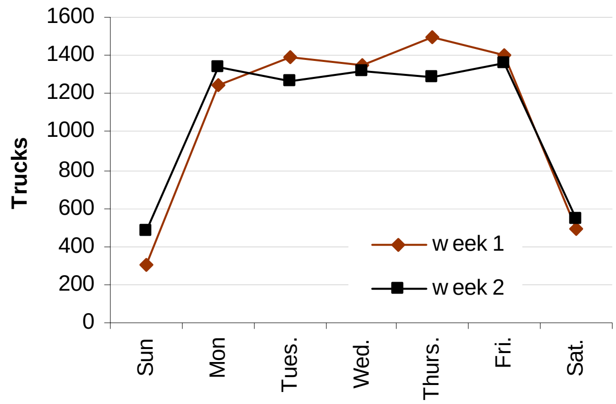
	Trucks	Percent
Logged In-Out Match (Counted Twice)	28,132	28%
Logged Out Only (Bobtail In)	35,505	36%
Logged In Only (Bobtail Out)	35,172	36%
Total for 3 months	98,809	100%

This estimated number of trips was subsequently compared to the actual number of lifts for the year, which was reported as 371,539 lifts (BNSF and Environ Consulting, 2007). This resulted in 1.064 truck trips per lift (empty, loaded, bare chassis) and 0.715 bobtail trips per lift. These were therefore, the generalized average rates (per lift) over the course of a year. The traffic analysis, however, evaluates traffic flows on a weekday and in particular it examines the flows during the morning and afternoon peak hours (when traffic on the roadways peaks due to area commuting patterns).

[2] The one hour time period was recommended by Environ staff because the shorter time frame available (30 minutes) could miss too many matches and the next longer time frame available (four hours) could introduce erroneous or multiple matches (i.e. observing the same truck three times in a time period).

Therefore, two weeks of recorded truck data was analyzed to develop a weekday factor. A summary of this data is presented in Figure A6. This analysis resulted in a weekday factor of 1.231 (ratio of the 5-day average to the 7-day average). A prior examination of monthly data had concluded that average daily lifts were fairly consistent over the year for which monthly data was available (*Traffic Study of the Proposed Logistics Park in Johnson County, KS*, HDR, 2006).

Figure A6: Recorded Trucks by Day of Week



The above trip rate information combined with the weekday factor was used to calculate an <u>average daily trip rate per million annual lifts</u> according to the following equation:

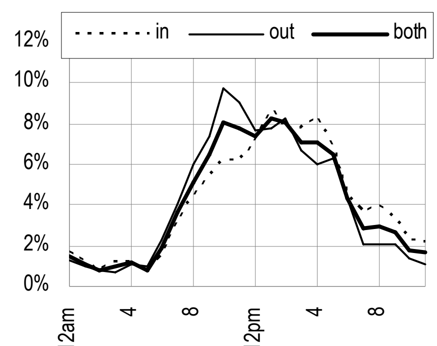
Average Daily Trip Rate Per Million Annual Lifts = (trips/lift) x 1,000,000 lifts/yr x weekday factor / 365 days/yr

Daily Truck Trips Per Million Annual Lifts = 1.064 trips/lift x 1,000,000 lifts/yr x 1.231 / 365 days/yr
~ 3588 daily truck trips per million annual lifts

Daily Bobtail Trips Per Million Annual Lifts = 0.761 trips/lift x 1,000,000 lifts/yr x 1.231 / 365 days/yr
~ 2566 daily bobtail trips per million annual lifts

As indicated in Table A1, the above trip rates result in 2,554 total truck trips (trailers and bobtails) for the opening day scenario with 0.415 million annual lifts. These average daily numbers were then adjusted to provide a.m. and p.m. peak hour trip rates through the use of hourly factors. The two weeks of daily truck count data was again examined to estimate peak period trips as a percent of daily trips and to estimate in-out flows. Data for one of the weeks is shown for reference in Figure A7. Based on this analysis the following values were used in the study: 5.5 percent of daily for the a.m. peak hour (40:60 in:out split) and 6.9 percent of daily for the p.m. peak hour (56:44 in:out split). The resulting trip rates are shown in Table A1.

Figure A7: Hourly Truck Percentages on a Weekday



Non-truck (primarily employee) traffic associated with the IMF was estimated based on employment and shift change data provided for the IMF. According to current plans, IMF ramp operation employees would comprise about 80 percent of the workforce and would have two shift changes per day (12 hour shifts). The remaining employees would have three shift changes per day (8 hour shifts). On a daily basis, a trip rate of 2.4 trips per employee was assumed to account for visitor, delivery, and other mid-day traffic. It is assumed that this rate also accounts for any carpooling and worker absences. Both sets of employees would change shifts at 7:00 a.m., therefore it was assumed that all of the 12 hour shift employees and two-thirds of the eight hour shift employees would arrive or depart during this hour. This resulted in an a.m. trip rate of 0.937 per employee. None of the shift changes would occur during the weekday p.m. peak hour, so the table shows minimal non-truck trip generation during that hour. Refer to the footnotes in Table A1 for additional information.

Given the above trip rate calculations, the number of trips generated by the IMF was calculated for each analysis year. These calculations were based on the lift count and employee data provided for each of those years. In 2010, the proposed IMF is expected to employ 143 employees with approximately 415,000 annual lifts. This is projected to generate 2,897 total daily trips on an average weekday with 273 and 185 trips expected during the a.m. and p.m. peak hours, respectively. In 2015, 495,000 annual lifts and 179 employees are forecasted for the facility leading to a commensurate increase in trip generation. In 2030, the Gardner IMF will have 288 employees with 870,000 lifts per year. This is projected to generate 6,045 daily trips on an average weekday with 563 trips during the a.m. peak hour and 388 trips during the p.m. peak hour.

Table A1: Trip Generation Assumptions and Results for the IMF and Induced Development

			Ave. Weekday		AM Peak Hour					PM Peak Hour				
					equiv		trips			equiv		trips		
	size	unit	rate	trips	rate	in: out	in	out	total	rate	in: out	in	out	total
Opening Year (2010)														
Intermodal Facility														
Trucks	0.415	million ann lifts	3588	1,489	196.36	40: 60	32	49	81	246.23	56: 44	57	45	102
Bobtail	0.415	million ann lifts	2566	1,065	140.454	40: 60	23	35	58	176.12	56: 44	41	32	73
Non-Trucks	143	emp	2.40	343	0.937	50: 50	67	67	134	0.072	35: 65	4	6	10
Total				2897			122	151	273			102	83	185
Induced Warehouse Development														
9 Trucks	360	emp	1.31	473	0.039	46: 54	6	8	14	0.044	57: 43	9	7	16
Non-Trucks				1,842			89	8	97			60	74	134
Total	360	emp	6.43	2,315	0.308	86: 14	95	16	111	0.417	46: 54	69	81	150
Total 2010				5,212			217	167	384			171	164	335
Trucks				1,962			38	57	95			66	52	118
Bobtail				1,065			23	35	58			41	32	73
Non-Trucks				2,185			156	75	231			64	80	144
2015														
Intermodal Facility														
Trucks	0.495	million ann lifts	3588	1,776	196.36	40: 60	39	58	97	246.23	56: 44	68	54	122
Bobtail	0.495	million ann lifts	2566	1,270	140.454	40: 60	28	42	70	176.12	56: 44	49	38	87
Non-Trucks	179	emp	2.40	430	0.937	50: 50	84	84	168	0.072	35: 65	5	8	13
Total				3476			151	184	335			122	100	222
Induced Warehouse Development														
9 Trucks	360	emp	1.31	473	0.039	46: 54	6	8	14	0.044	57: 43	9	7	16
Non-Trucks				1,842			89	8	97			60	74	134
Subtotal	360	emp	6.43	2,315	0.308	86: 14	95	16	111	0.417	46: 54	69	81	150
1 Trucks	132	emp	1.31	173	0.038	46: 54	2	3	5	0.045	57: 43	3	3	6
Non-Trucks				676			33	3	36			22	27	49
Subtotal	132	emp	6.43	849	0.311	86: 14	35	6	41	0.417	46: 54	25	30	55
10 Trucks	360	emp	1.31	473	0.039	46: 54	6	8	14	0.044	57: 43	9	7	16
Non-Trucks				1,842			89	8	97			60	74	134
Subtotal	360	emp	6.43	2,315	0.308	86: 14	95	16	111	0.417	46: 54	69	81	150
6 Trucks	366	emp	1.31	481	0.041	46: 54	7	8	15	0.044	57: 43	9	7	16
Non-Trucks				1,873			90	8	98			61	76	137
Subtotal	366	emp	6.43	2,354	0.309	86: 14	97	16	113	0.418	46: 54	70	83	153
7 Trucks	138	emp	1.31	181	0.043	46: 54	3	3	6	0.043	57: 43	3	3	6
Non-Trucks				706			34	3	37			24	28	52
Subtotal	138	emp	6.43	887	0.312	86: 14	37	6	43	0.420	46: 54	27	31	58
3 Trucks	240	emp	1.31	315	0.042	46: 54	5	5	10	0.046	57: 43	6	5	11
Non-Trucks				1,228			58	6	64			40	49	89
Subtotal	240	emp	6.43	1,543	0.308	86: 14	63	11	74	0.417	46: 54	46	54	100
2 Trucks	120	emp	1.32	158	0.042	46: 54	2	3	5	0.042	57: 43	3	2	5
Non-Trucks				614			30	2	32			20	25	45
Subtotal	120	emp	6.43	772	0.308	86: 14	32	5	37	0.417	46: 54	23	27	50
Warehouse Sub-Total	1,716	emp		11,035			454	76	530			329	387	716
Trucks	1,716	emp		2,254			31	38	69			42	34	76
Non-Trucks				8,781			423	38	461			287	353	640
Total 2015				14,511			605	260	865			451	487	938
Trucks				4,030			70	96	166			110	88	198
Bobtail				1,270			28	42	70			49	38	87
Non-Trucks				9,211			507	122	629			292	361	653
2030														
Intermodal Facility														
Trucks	0.870	million ann lifts	3588	3,121	196.36	40: 60	68	103	171	246.23	56: 44	120	94	214
Bobtail	0.870	million ann lifts	2566	2,233	140.454	40: 60	49	73	122	176.12	56: 44	86	67	153
Non-Trucks	288	emp	2.40	691	0.937	50: 50	135	135	270	0.072	35: 65	7	14	21
Total				6045			252	311	563			213	175	388
Induced Warehouse Development														
Trucks	1,716	emp		2,254			31	38	69			42	34	76
Non-Trucks				8,781			423	38	461			287	353	640
Total	1,716	emp		11,035			454	76	530			329	387	716
Total 2030				17,080			706	387	1,093			542	562	1,104
Trucks				5,375			99	141	240			162	128	290
Bobtail				2,233			49	73	122			86	67	153
Non-Trucks				9,472			558	173	731			294	367	661

Assumptions for each category:

Intermodal Daily Trucks - Annual lifts are converted to daily (7-day average), weekday, and peak-hour truck trips through a series of conversion factors developed based on existing operations at the BNSF Argentine intermodal facility in Kansas City, Kansas.

Intermodal Employees - On an average weekday, it is assumed that there are approximately 2.4 non-truck trips per employee. This includes two commute trips per employee plus a 20% factor for deliveries, visitors, and other mid-day trips. This number is also assumed to account for trip reductions related to carpooling and absences. Based on expected shift-change times, very few employee trips are expected during the p.m. peak hour. Therefore, it is assumed that a modest 3% of the weekday non-truck trips occur in the p.m. peak hour (or 0.072 trips per employee with 65% exiting). It is assumed however, that both ramp and non-ramp employees will have a shift change during the morning peak hour. This results in an a.m. peak hour trip rate of approximately 0.937 non-truck trips per employee. Employee traffic is divided into two general shift change categories:

- ramp operation employees (80% of workforce), with 2 shifts changing at 7 a.m. and 7 p.m.
- remaining employees (20% of workforce), with 3 shifts changing at 7 a.m., 3 p.m. and 11:00 p.m.

Induced Warehouse Development - Warehouse development in 2010 is 600,000 square feet. Warehouse development in 2015 and 2030 is 2.86 million square feet. Based on available data it is estimated that there are 0.6. employees per 1,000 square feet. Weekday, am peak hour, and pm peak hour trip rates are based on data presented in Truck Trip Generation Study, City of Fontana, California, August 2003.

<u>Proposed Action and 2015 Gardner IMF Operations Trip Distributions and Forecasts</u>
Trip distribution is the process of estimating where vehicle trips will begin and end. For the Proposed Action and the 2015 Gardner IMF Operations scenarios, the new trips generated by the IMF were distributed as shown in Figure A8. For non-truck traffic, the distribution was developed based on current traffic volumes and street classifications, local land use patterns, and the results of the 2030 Gardner IMF model runs. Truck traffic was distributed based primarily on the results of a BNSF high-volume shipper survey for shippers at the Argentine Yard, a SmartPort metro-wide inventory of distribution centers, and the truck assignment in the 2030 Gardner IMF model runs. The results of the first two of these items are illustrated in Figure A9. For more information on the distribution of the IMF truck traffic, please refer to the *I-35 Break-in-Access Study* – Appendix A (HDR, 2007)

Based on the distributions shown, the IMF traffic was assigned to the local roadways and intersections. The assignment assumed that IMF trucks/bobtails were restricted from using 183rd Street between Waverly Road and Gardner Road. Once the 2010 and 2015 IMF distribution and assignment were complete, the IMF project trips were added to the No Action traffic volumes to create the composite 2010 Proposed Action and 2015 Gardner IMF Operations volumes as illustrated in the body of the report.

Figure A8: 2010 and 2015 Gardner IMF Trip Distributions

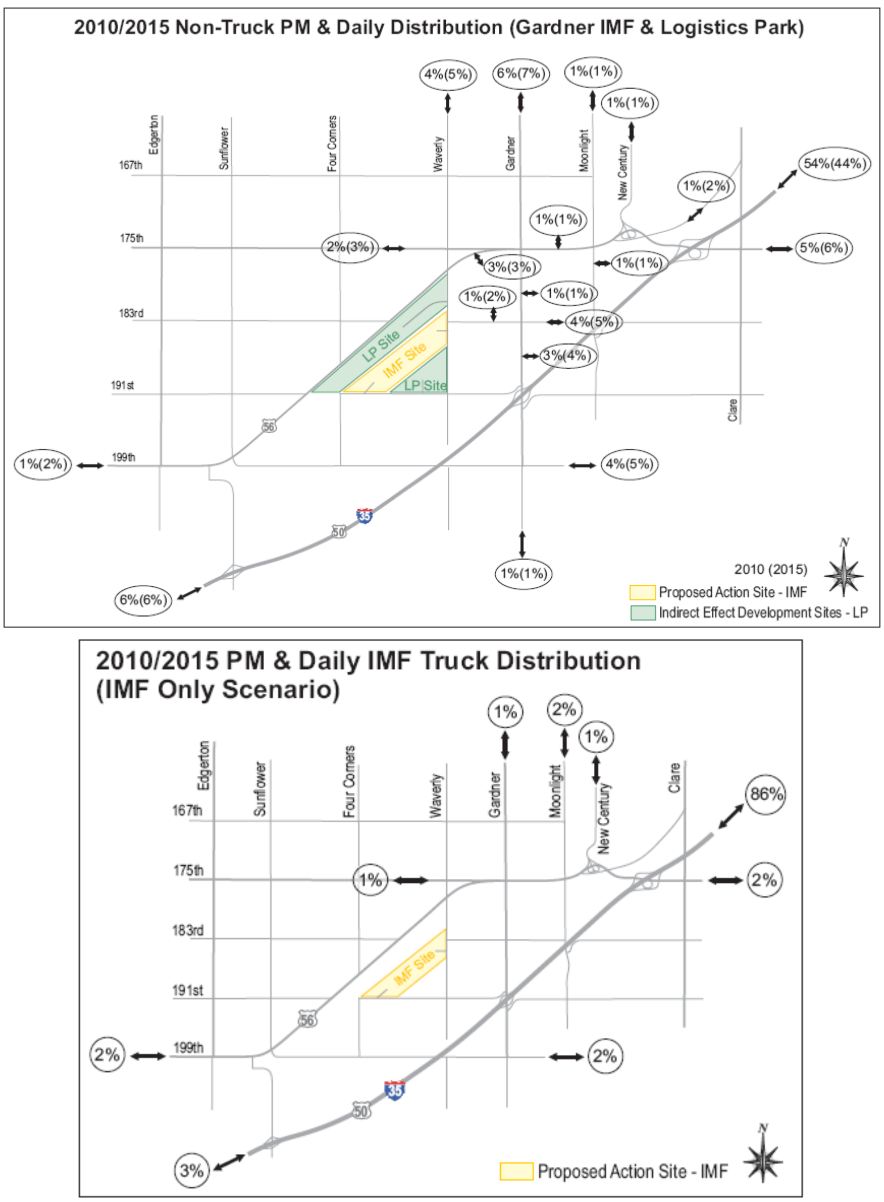
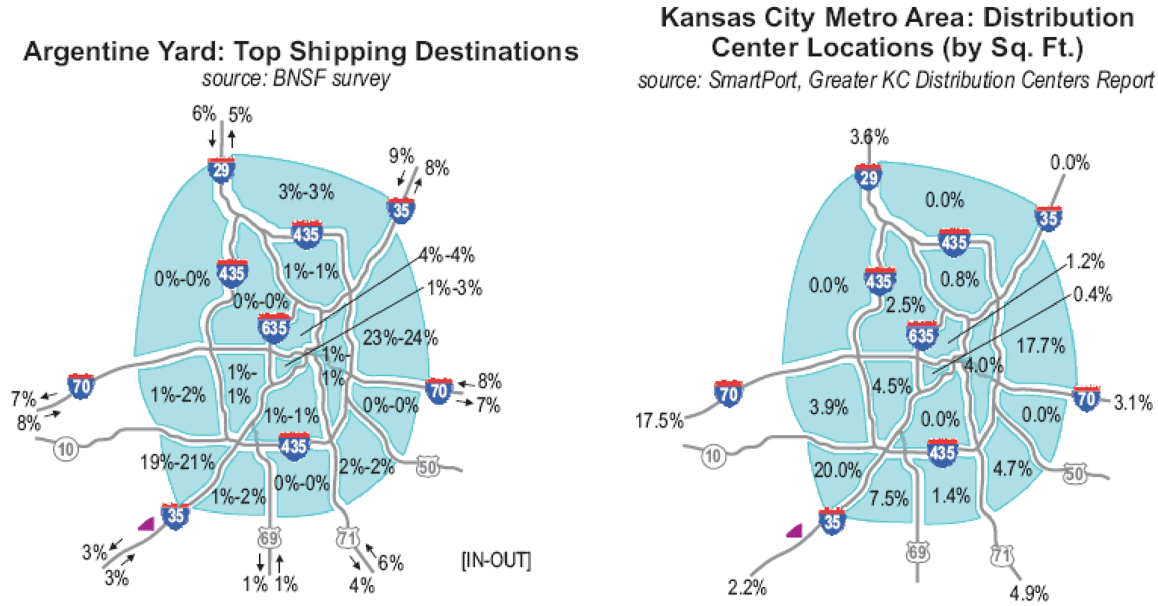


Figure A9: Sources of Data for Gardner IMF Truck Trip Distribution



<u>2030 Gardner IMF Operations Trip Distributions and Forecasts</u>
For 2030, the trip generation shown in Table A1 was approximated in the OTM through the use of "proxy" land uses and matrix manipulation. Because the Gardner IMF land use is unique and its trip generation rates do not match any of the general rates used throughout the Olathe model, land-use totals were input into the model to "force" the desired trip generation totals. The subsequent origin-destination matrix was then further modified to approximate the trip generation total more exactly.

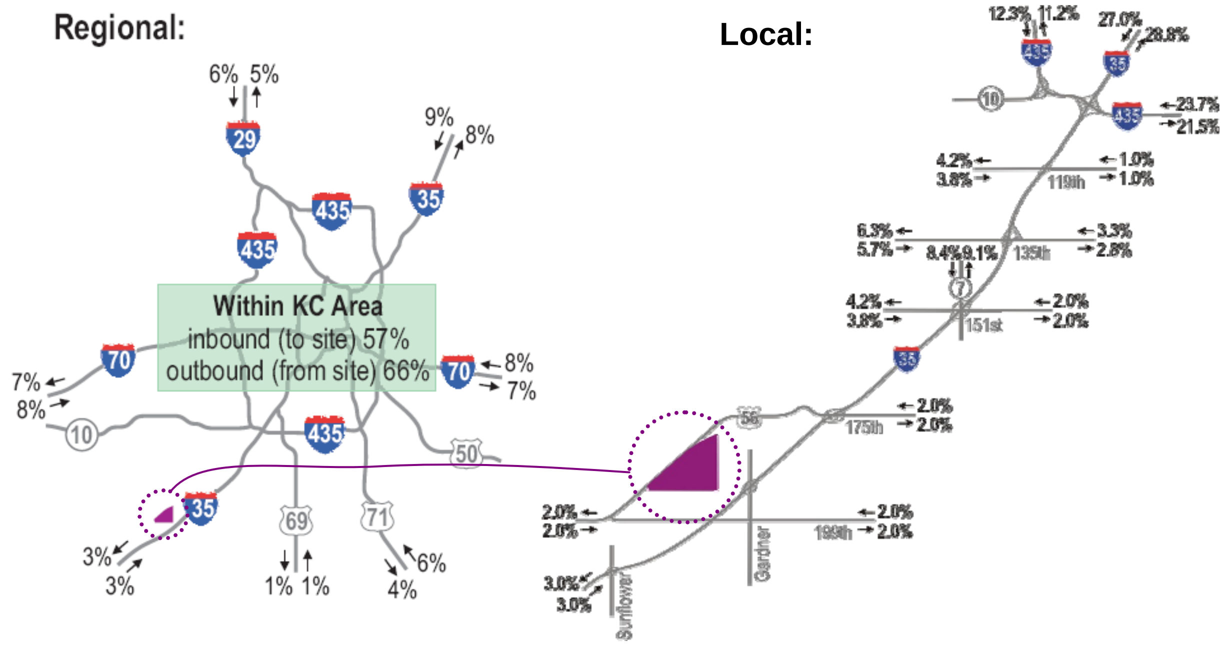
The Olathe model was used to both distribute and assign the 2030 non-truck trips generated by the IMF. The distribution was a standard "gravity" model distribution, which takes into account the number of trips produced and attracted by different "zones" and the travel time between zones to calculate the traffic flows between any two zones. Once the flows are determined, the model then assigns the traffic to the roadway network in such a way that travel time is minimized. The model takes into account the capacity limitations of the road system and will assign traffic away from congested areas if that results in faster travel times. This process was used for all of the assumed 2030 land uses in the model. The Gardner IMF truck traffic however, had to be distributed differently.

The current OTM does not include an explicit, separate truck component. Instead, trucks generated by existing and future development are implicitly included in the vehicular volume projections. (This is a standard model assumption used in many urban areas.) This means that the model does not distribute truck traffic any differently than all other traffic, and it does not take into account the effects of vehicle equivalency factors on capacity (the fact that trucks consume roadway capacity at a higher rate than non-trucks). Therefore, since the Gardner IMF will generate a higher percentage of truck traffic than would most typical non-residential uses, if the standard gravity model approach was used to distribute and assign the truck traffic, it would not appropriately assess the project impacts in the Gardner Traffic Study Area. First, it would be difficult to separate the truck traffic generated by the IMF from the auto traffic generated by the IMF. Second, because the model would distribute trucks the same way as cars, it would understate truck volumes on some roadways, while overstating them on others. The model would not assign the truck traffic in a manner consistent with its more regional and interstate origins and destinations. However, development of a separate truck component for the entire OTM would be a significant undertaking and was well outside the scope of this study.

Therefore, a third option was developed, where the 2030 truck traffic generated by the Gardner IMF was distributed deterministically based in part on the previously discussed truck origin-destination data from the Argentine Yard. These 2030 distribution assumptions were commented on and updated as part of the

I-35 BIA study process. The resulting regional 2030 IMF truck distribution is presented in Figure A10. As part of this process, the truck trip generation data was combined with the origin-destination information to create a truck traffic matrix defining the amount of truck traffic traveling between the IMF and various model zones and external stations. The model's assignment process was then used to assign that traffic to the roadway system. This allowed the model to predict which route would provide the shortest travel time. The assignment employed a 1.5 vehicle equivalency factor for trucks. It also included truck restrictions on both 183rd Street and 191st Street between Waverly Road and Gardner Road. Overall, the results of the modeling approach yielded reasonable volume forecasts for considering the 2030 volumes and impacts of the 2030 Gardner IMF Operations truck traffic.

Figure A10: 2030 Gardner IMF Truck Distribution



The network used for the 2030 Gardner IMF Operations model runs was similar to the No Action network except in the vicinity of the Proposed Action. As outlined above, the Proposed Action includes three street closures that were modeled (183rdStreet, Four Corners Road, and 191st Street). Roadway capacities and speeds in the area were set at appropriate levels and the IMF driveways were located as shown in the site plan. In addition, model assumptions were modified with respect to train crossing volumes.

As described above, the model assigned both auto and truck traffic to the roadway network based on an equilibrium process that minimizes user travel times. This final assignment provided the raw a.m., p.m., and daily model output which was then adjusted in the same manner as the No Action Scenario output. The adjusted final volumes were then presented in figures (in the body of the report) and used in the capacity analysis.

Gardner IMF Operations + Induced Development Traffic Forecasts

This section describes the traffic forecasts for the 2010, 2015, and 2030 scenarios that include the reasonably foreseeable induced warehouse development that would result from the Gardner IMF.

<u>Induced Development Assumptions</u>

Information on the potential size and location of the induced warehouse development in the vicinity of the Gardner IMF was provided by the Allen Group of Kansas. Based on this information, it was assumed that one 600,000 square foot warehouse building would be constructed in the vicinity of the IMF by 2010 and that 2.86 million square feet of warehouse space would be constructed by 2015. Based on the information provided by the Allen Group of Kansas, no further development was assumed to be reasonably foreseeable by 2030.

Induced Development Trip Generation

The auto and truck trips projected to be generated by the induced development are presented in Table A1 for 2010, 2015, and 2030. A number of approaches were explored for estimating the warehouse trip generation. This includes a thorough review of Institute of Transportation Engineer (ITE) rates, data from the 2003 City of Fontana *Truck Trip Generation Study*, and background information from other studies.

The ITE *Trip Generation* manual (7th Ed.) presents rates for warehouse and high-cube warehouse uses. However, these ITE rates did not include separate trip rates for trucks and the separation of auto and truck trips was deemed critical for this study. In fact, the ITE manual indicated that the Fontana study (actually a previous version) be consulted for truck trip rates. In addition, a detailed examination of the ITE data revealed that much of the data was from 1960 through 1990 (and nearly all of the data from east and west coast locations). Thus, it was not clear that the ITE data was representative of modern warehouse and trucking industry practices.

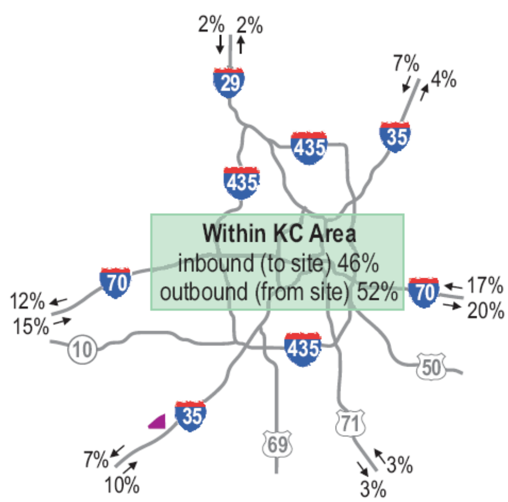
Therefore, it was decided that the Fontana Study was the best source of recent warehouse trip generation information. It also provided the necessary truck and auto trip rate information. The Fontana data was examined in considerable detail before being used for this study and appropriate daily, a.m. peak, and p.m. peak rates were employed for the analysis. The rates used are shown in Table A1 along with the resulting trip volumes.

Once these volumes were set, the truck flows between the warehouse development and the Gardner IMF were estimated for all scenarios. Based on discussions held with the agencies during the I-35 BIA Study process, it was assumed that approximately 25 percent of the warehouse traffic would travel to and from the Gardner IMF. These trips were assigned directly to and from the Gardner IMF site (with the duplicate trips eliminated).

2010 and 2015 Induced Development Distribution and Final Volumes

For 2010 and 2015, separate auto and truck trip distributions were assumed for the induced warehouse development. The non-truck distribution was the same as that employed for the Gardner IMF as shown at the top of Figure A8. It was developed based on local traffic volumes, highway classifications, local land-use, and the output from the 2030 Gardner IMF + Induced Development modeling work.

Figure A11: Regional Warehouse Trip Distribution Assumptions



Similar to the Gardner IMF truck distribution assumptions, the warehouse truck distribution was developed based on a variety of data sources. Regional truck distribution assumptions were based primarily on the Goods Movement Element of MARC's *Transportation Outlook 2030 Update and t*he U.S. Census 2002 Commodity Flow Survey (CFS) database. The regional distribution resulting from these sources is illustrated in Figure A11.

The local distribution was based on U.S. Census population data (for allocations within the region), local land-use and transportation data, and the results of the 2030 Gardner IMF + Induced Development model runs. The specific 2010 / 2015 warehouse truck distribution used for the Gardner traffic study area is illustrated in Figure A12. For more information on the development of the warehouse truck distribution refer to the I-35 BIA Appendix A.

One of the projected effects of the induced development is that it would change the distribution of Gardner IMF truck traffic. This is due mainly to the interaction between the two developments, whereby some trucks travel back and forth between the IMF and the warehouse development instead of leaving the area going to and from other destinations. The modified IMF truck distributions are shown in Figure A13. There are separate daily and peak hour distributions because, while the percentage of warehouse traffic related to the IMF was kept constant (at approximately 25 percent), the resulting percentage of IMF traffic was different for the different time periods.

Figure A12: 2010 and 2015 Induced Warehouse Development Truck Distribution

Once the various truck and non-truck trip distributions were set, the traffic was assigned to the local roadways and then added to the No Action volumes to derive final volumes for the 2010 and 2015 Gardner IMF Operations + Induced Development Scenarios. These volumes are presented in the body of the report and provided key inputs to the capacity analysis.

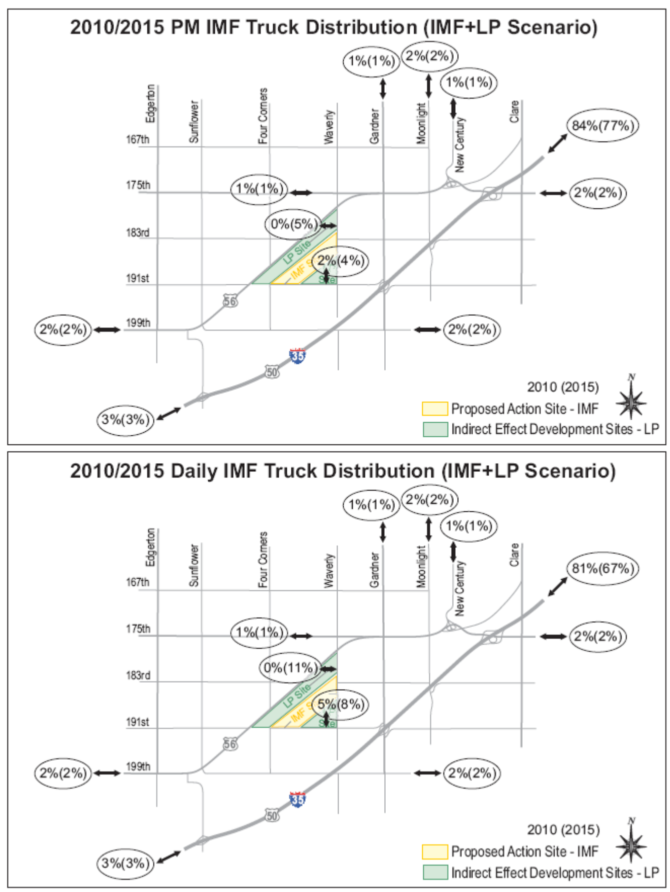
<u>2030 Induced Development Forecasts</u>

For the 2030 Gardner IMF Operations + Induced Development scenario, the OTM was again used. This time, in addition to coding the Gardner IMF trips using "proxy" land uses, the Induced Development (warehouse) trips were also coded using "proxy" land uses. Again, matrix manipulation was used to make sure the trip origins and destinations for each analysis period (a.m., p.m., and daily) were very close to what was forecasted in the trip generation step.

The model network used for this analysis was very similar to that used for the 2030 Gardner IMF Operations scenario. One change that was assumed was that the service road located north of the IMF and south of the BNSF mainline tracks would be connected by 2030 at its western end to 191st Street near Four Corners Road. This provided a second access/egress point for development along the service road in this 2030 scenario.

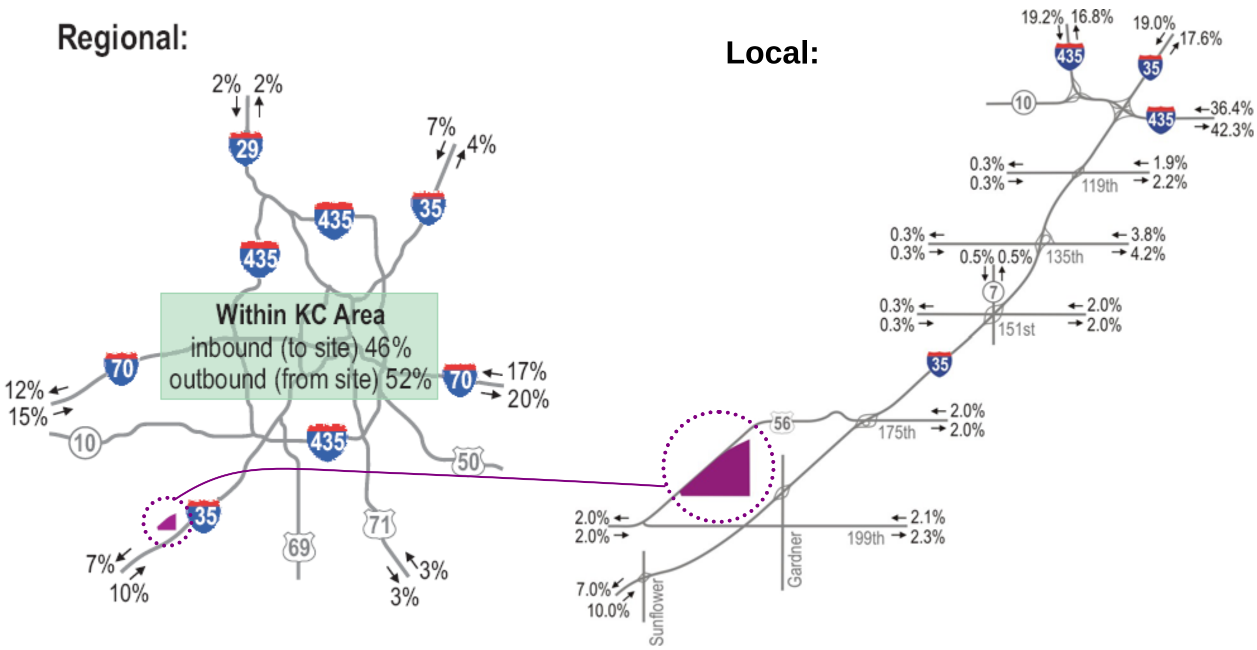
Overall, the same modeling procedure was used for this scenario as was used for the 2030 Gardner IMF Operations scenario. Autos were distributed and assigned by the model, while the commercial trucks were again assigned based on regional distribution assumptions. The regional warehouse truck traffic distribution was based on data from MARC and the US Census Bureau as discussed in the *2010 and 2015 Induced Development Distribution and Final Volumes* section. The resulting truck distribution that was used to create the truck model matrix (with origins and destinations) is shown in Figure A14. Similar to the 2030 Gardner IMF Operations truck distribution, these assumptions were reviewed and modified by

Figure A13: 2010 and 2015 Gardner IMF Truck Distribution (With Induced Development Constructed)



the Agencies as part of the I-35 BIA study process. The resulting model output was post processed as before and the final volumes were presented in the body of the report and used in the capacity analysis.

Figure A14: 2030 Induced Warehouse Development Truck Distribution



Wellsville North Alternative Traffic Forecasts

<u>Wellsville North Alternative</u>
The Wellsville North Alternative is described in Chapter 2 of the Draft Environmental Report. It includes the following major elements in relation to traffic flow on the highway transportation system:

- Improvement of Sunflower Road from I-35 to 207th Street
- Improvement of 207th Street between Sunflower Road and Evening Star Road including structures and grade separation of the mainline and intermodal lead tracks and relocation of Co-op Road.
- Improvement of Evening Star Road for a distance of approximately 5400' from 207th Street to the project site.
- Grade Separation of Edgerton Road over the mainline and intermodal lead tracks
- Grade Separation of 223rd/Thomas Road over the mainline tracks, intermodal leads and ladder tracks into the yard
- Grade separation of Main Street in Wellsville over the mainline and intermodal lead tracks.
- Closure of 215th Street between Edgerton Road and Wyoming Street

It was assumed that site access for trucks and employees is via driveways from near the Evening Star Road / 215th Street intersection.

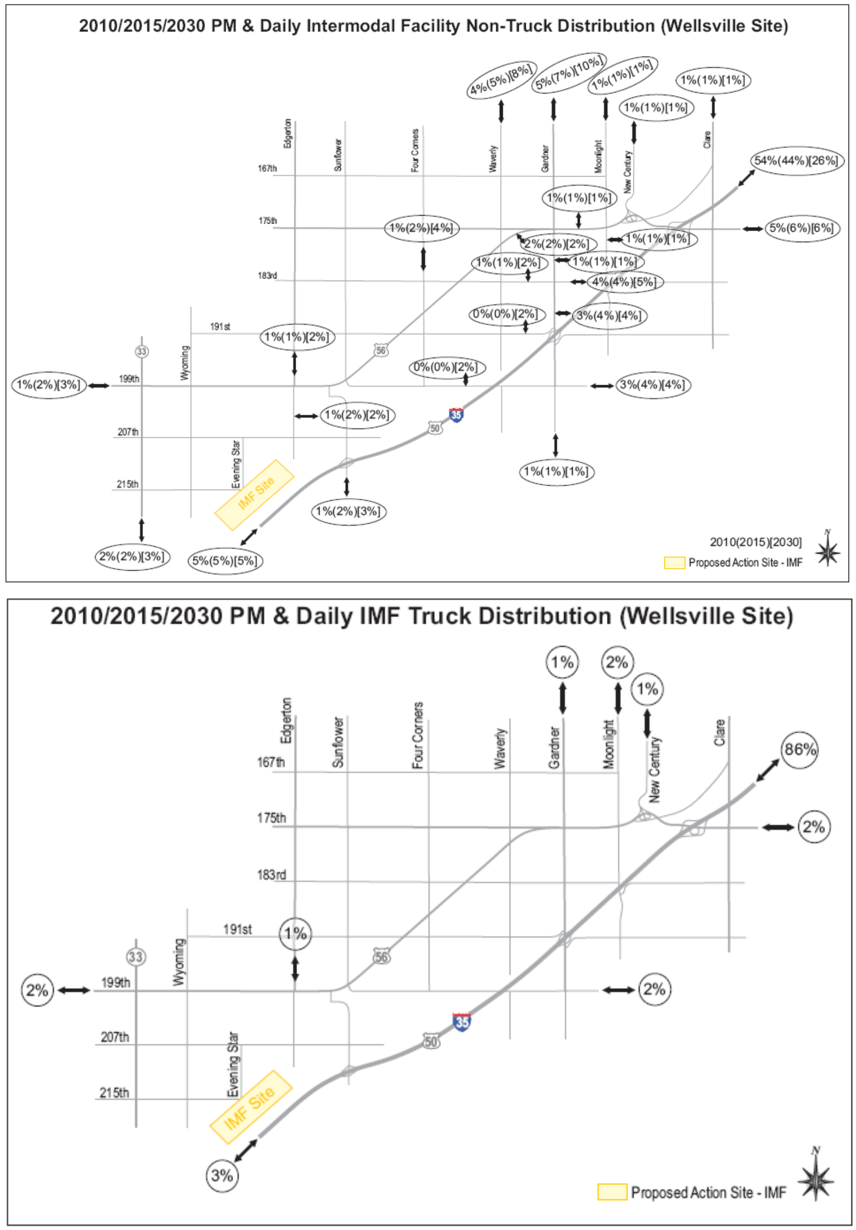
<u>Wellsville North Alternative Trip Generation</u>
The Wellsville North Alternative IMF was assumed to have the same trip generation characteristics as the Gardner IMF. Refer to Table A1 for a summary of the IMF trip generation by year.

Wellsville North Alternative Trip Distribution and Volume Forecasts

The Wellsville North Alternative is located outside of the Olathe model area. Therefore, standard manual traffic distribution and assignment methods were used for all three forecast years (2010, 2015, and 2030) and all three time periods (a.m., p.m., and daily). Given this approach, the auto trip distribution assumptions for the Wellsville North Alternative were set based on existing traffic volumes and highway classifications, local land-uses (current and projected), and the results of the 2030 Gardner IMF Operations modeling analysis. The truck distribution was based primarily on the same shipper survey / distribution center inventory information that was used for the Gardner IMF. The resulting auto and truck distributions are illustrated in Figure A15.

The Wellsville North IMF traffic was deterministically assigned to the local roadway system. These assigned volumes were then added to the No Action volumes to yield the Wellsville North Alternative scenario volumes. These volumes were presented in the body of the report and were used for the Wellsville North Alternative capacity analysis.

Figure A15: Wellsville North Alternative IMF Trip Distribution



Traffic Operations Analysis Methods

The traffic analysis approach was consistent with standard traffic engineering practice and was based upon several methodology sources, including:

- *Highway Capacity Manual (HCM)* – Transportation Research Board (TRB), 2000
- *Manual of Uniform Traffic Control Devices (MUTCD)* – FHWA, 2003 Edition
- *A Policy on Geometric Design of Highways and Streets* - AASHTO, 2004

The operational analysis focused on the critical weekday a.m. and p.m. peak hours, though daily traffic volume data was presented as well. For all scenarios, a peak-period capacity analysis was prepared based on the methods presented in the *Highway Capacity Manual*. The HCM provides standard traffic operational analysis methods for intersections, freeways, and ramps (merge and diverge).

Level of Service

Level of Service (LOS) is the fundamental HCM parameter describing operational conditions within a traffic stream. LOS is an A-through-F letter ranking scale with LOS A indicating free-flow, low density, or nearly negligible delay conditions and LOS F indicating facility breakdown with low speeds, high densities, and high delay. For intersections, LOS is based on the average control delay per entering vehicle measured in seconds. Control delay includes not only stops at intersections, but also slower speeds as vehicles advance in queue or decelerate upstream of an intersection. For signalized and all-way stop-controlled intersections, individual approach delays as well as an overall average delay are calculated for each intersection. For one and two-way stop-controlled intersections, the delay is only reported for non-free movements. For freeway elements (including both segments and ramps), LOS is based on density, defined as the number of vehicles per mile per lane. Table A3 shows the LOS criteria used in this study. The HCM methods were implemented using the Highway Capacity Software (HCS+) for freeways and ramps, and the Synchro Version 7 software for intersections.

Table A3: Level of Service

Level of Service	Intersections			Freeways		
	Description	Control Delay (sec/veh)		Description	Maximum Density (veh/mi/ln)	
		Signalized	Unsignalized		Mainline	Ramps
A	Most vehicles do not stop	≤ 10	≤ 10	Free flow	11	10
B	Some vehicles stop	> 10 and ≤ 20	> 10 and ≤ 15	Slight restriction to free flow	18	20
C	Significant number of stops	> 20 and ≤ 35	> 15 and ≤ 25	Restrictions to free flow	26	28
D	Many stop, individual cycle failure	> 35 and ≤ 55	> 25 and ≤ 35	Noticeable restriction, declining speeds	35	35
E	Frequent individual cycle failure, at capacity	> 55 and ≤ 80	> 25 and ≤ 50	No gaps in traffic, volatile speeds	45	>35
F	Arrival rate exceeds capacity	> 80	Demand > capacity	Breakdown, large queues, recurring congestion	>45	demand > capacity

Source: Highway Capacity Manual (HCM), 2000

LOS Thresholds

Based on AASHTO's *A Policy on Geometric Design of Highways and Streets,* operations within a rural area should target a Level of Service (LOS) C or better for future conditions; for urban areas, the guidelines suggest a target LOS of D or better. For this study, since many of the critical intersections are either in developed areas (e.g. Downtown Gardner), rapidly developing areas (e.g. I-35 / US 56 interchange area) or in areas that are expected to develop over the 22-year planning horizon (e.g. I-35 / Gardner Road Interchange area), a minimum standard of LOS D was chosen, along with LOS C as a desirable goal.

Highway-Rail At-Grade Crossing Analysis

The central element of the Proposed Action is the construction of a rail-truck intermodal facility. Given that this facility would affect both train speeds and local train routing, it was determined that an analysis of the highway-rail at-grade crossings was important. A review of the available analysis tools for examining at-grade crossings gave mixed results. In fact, one source stated, “Numerous methods to estimate delay at gated crossings have been tested, but there is no universally accepted procedure.” Therefore, in order to properly investigate the change in critical operating characteristics for the various study scenarios, a set of detailed spreadsheets were developed. The spreadsheets included a range of operational data such as train volumes, train speeds, train lengths, and highway volumes (train operational data was supplied by BNSF). The data allowed for a calculation of approximate blocked time (the time the roadway was blocked to highway traffic).Then using a set of equations related to queuing theory, estimates were developed for other key parameters such as average highway vehicle delay and how many highway vehicles were delayed at the crossing.

Key Assumptions

1. Factors were used to convert average daily trains (7-day average) to average weekday trains (Tuesday to Thursday). The approximate factors were: All trains: 0.96 Intermodal Trains: 0.98

2. Through trains were assumed to be split 50 percent eastbound and 50 percent westbound over the course of the day.

3. The analysis assumed two tracks at each at-grade crossing. Currently, four of the nine roadways with major at-grade crossings are double-track crossings. The remaining roadways have two separate single-track crossings that, for analysis purposes, have an effect similar to one double-track crossing.[3] In addition, in the Gardner IMF scenarios, the major single-track crossings would either be eliminated (183rd Street, Four Corners Road, and 191st Street) or consolidated into double-track crossings (Waverly Road and 199th Street).

4. The roadway saturation flow was assumed to be 1,600 vehicles per hour per lane.

5. Train flows were assumed to be uniform. Therefore, average weekday trains divided by 24 hours would provide the average expected number of trains during any one hour.

6. Through trains were assumed to occasionally pass each other, thereby reducing the total amount of blocked time due to all trains, but increasing the length of time for some of the individual blockages. A probability was assigned to this occurrence in keeping with the expected number of trains per hour. The resulting probability was low and had a minimal effect on the analysis results.

Key Equations

Average Blocked Time for a Single-Train Crossing Event
Average blocked time for a single train crossing event was calculated based on the length of the train and the average speed of the train plus warning and gate time. The warning and gate time was conservatively assumed to be 40 seconds total for each crossing. This included the time before the train arrived and after the train departed from the crossing (e.g. flashing light warning time, gate closing time, gate down time before and after the train, and gate opening time). The 40 seconds was added to the estimated time that the train was physically across the roadway to give a total "blocked time" estimate.

$$BT = TL / TS + 40 \text{ sec}$$

BT = Average Blocked Time (sec)
TL = Average Train Length (feet)
TS = Average Train Speed (feet/sec)
40 seconds is the additional warning / gate time

Average Blocked Time for a Two Train Crossing Event
In the fairly rare event of two trains passing each other across an at-grade crossing, the total blocked time will increase above that for a single train event. The minimum blockage would occur if the fronts of both trains arrived at the crossing at the same time. In this situation, the blockage would be the same as for a single train event (assuming both trains were the same length and were traveling the same speed). The maximum blockage would occur when a second train arrived just as the first train finished crossing. In this case the blockage would be approximately equal to two single-event blockages. Therefore, the average blocked time for a two train event would be midway between these two extremes. Average blocked time for a two-train event was calculated as follows:

$$BT_{12} = (MAX(BT_1, BT_2) + BT_1 + BT_2) / 2$$

BT_{12} = Average blocked time for two trains passing each other at an at-grade crossing (sec)
BT_1 = Average blocked time for train crossing in the eastbound direction (sec)
BT_2 = Average blocked time for train crossing in the westbound direction (sec)

[3] 191st Street has only one single-track crossing, but the southern single-track crossing on Four Corners Road also affects through traffic on 191st Street so it was treated in the same manner as all of the other roadways.

Total Average Blocked Time Per Hour for a Crossing (min/hr)

The total average blocked time per hour presents the average cumulative number of minutes each hour that the at-grade crossing is blocked to highway vehicles. It is the sum of the blocked times for each of the possible train crossing events (single eastbound train, single westbound train, simultaneous eastbound and westbound trains) multiplied by the average hourly frequency of each event.

$BT_{tot} = ((BT_1 \times T_1) + (BT_2 \times T_2) + (BT_{12} \times T_{12})) / 60$ *sec/min*

BT_1 = *Average blocked time for train crossing in the eastbound direction (sec)*
BT_2 = *Average blocked time for train crossing in the westbound direction (sec)*
BT_{12} = *Average blocked time for simultaneous train crossings in the EB and WB directions (sec)*
T_1 = *Expected train crossings in the eastbound direction (trains / hour)*
T_2 = *Expected train crossings in the westbound direction (trains / hour)*
T_{12} = *Expected simultaneous train crossings in the eastbound and westbound direction (events / hour)*

Expected Train Crossing Probabilities and Expected Train Crossings Per Hour
As outlined in the assumptions discussion, the train arrival patterns were assumed to be uniform in this analysis. The one complication introduced into this assumption was that through trains in opposite directions could arrive at the same time. To estimate the number of train crossing events, probabilities were first assigned to each.

Probability of Two Trains Passing the Crossing at the Same Time
$P_{12} = (F_1 \times BT_1 / (3600*24)) \times (F_2 \times BT_2 / (3600*24))$

F_1 = *Frequency of eastbound trains (trains per day)*
F_2 = *Frequency of westbound trains (trains per day)*
BT_1 = *average blocked time for train crossing in the eastbound direction (sec)*
BT_2 = *average blocked time for train crossing in the westbound direction (sec)*

Probability of Only One Train Passing the Crossing (One Direction)
$P_1 = (F_1 \times BT_1 / (3600*24)) \times (1 - (F_2 \times BT_2 / (3600*24)))$

F_1 = *Frequency of eastbound trains (trains per day)*
F_2 = *Frequency of westbound trains (trains per day)*
BT_1 = *average blocked time for train crossing in the eastbound direction (sec)*
BT_2 = *average blocked time for train crossing in the westbound direction (sec)*

Based on the above probabilities it was possible to calculate the expected number of crossing events per hour for use in further analysis.

Expected Two-Train Crossing Events Per Hour
$T_{12} = (T_{U1} + T_{U1}) \times (P_{12} / (P_1 + P_2 + (P_{12} \times 2))) / 2$

T_{U1} = *Unadjusted trains per hour (total eastbound trains / 24 hours)*
T_{U2} = *Unadjusted trains per hour (total westbound trains / 24 hours)*
P_{12} = *Probability of two trains passing the crossing at the same time*
P_1 = *Probability of eastbound train passing the crossing*
P_2 = *Probability of westbound train passing the crossing*

Expected One-Train Crossing Events Per Hour (One Direction)
$T_1 = (F_1 / 24) – T_{12}$

F_1 = *Frequency of eastbound trains (trains per day)*
T_{12} = *Expected Two-Train Crossing Events Per Hour*

Vehicles Queued During a Blockage (not including queue clearance time)
The number of highway vehicles that will queue in one direction during a crossing event can be determined based on the length of the blockage and the number of vehicles arriving on the highway in that direction. For example:

$$Q_{1w} = BT_1 \times (V_w / 3600)$$

BT_1 = *average blocked time for train crossing in the eastbound direction (sec)*
V_w = *Highway volume in the westbound or northbound direction at the crossing*

Queue Clearance Time
The time to clear the queue in one direction is related to the length of the queue, the number of arriving vehicles, the saturation flow, and the number of lanes. For example:

$$QC_{1w} = Q_{1w} / ((N_w \times S / 3600) - (V_w / 3600))$$

Q_{1w} = *Vehicles queued in the westbound or northbound direction during* BT_1
N_w = *Number of westbound or northbound lanes on highway*
S = *Saturation flow (veh/lane/hr)*
V_w = *Highway volume in the westbound or northbound direction at the crossing (veh/hr)*

Maximum Vehicles In Queue
The maximum vehicles in a queue as a result of a crossing being blocked are a function of the blocked time, the highway volume, and the queue clearance time. For example:

$$Q_{1wmax} = (BT_1 + QC_{1w}) \times (V_w / 3600)$$

BT_1 = *average blocked time for train crossing in the eastbound direction (sec)*
QC_{1w} = *time to clear queue in the westbound or northbound direction after* BT_1
V_w = *Highway volume in the westbound or northbound direction at the crossing (veh/hr)*

Vehicles Queued or Delayed Per Hour
The approximate number of vehicles queued (or delayed) per hour is equal to the total vehicles queued per crossing event multiplied by the probability of the crossing event.

$$Q_{1tot} = T_1 \times (Q_{1wmax} + Q_{1emax})$$

Q_{1wmax} = *Maximum vehicles in queue (eastbound train westbound or northbound vehicles)*
Q_{1emax} = *Maximum vehicles in queue (eastbound train eastbound or southbound vehicles)*
T_1 = *Expected one-train crossing events per hour (eastbound direction)*

To estimate the total vehicles queued (or delayed) from all trains at a crossing ($\mathbf{Q_{tot}}$), three values must be summed: eastbound trains, westbound trains, and simultaneous trains.

$$Q_{tot} = Q_{1tot} + Q_{2tot} + Q_{12tot}$$

Vehicular Crossing Delay Per Train (sec)
The delay to vehicles per train crossing event is related to the length of the blockage, the volume of vehicles, the number of lanes, and saturation flow according to the following equation:

$$D_{1w} = (N_w \times S \times V_w \times (BT_1 / 3600)^2) / (2 \times (N_w \times S - V_w)) \times 3600$$

N_w = *Number of westbound or northbound lanes on highway*
S = *Saturation flow (veh/lane/hr)*
V_w = *Highway volume in the westbound or northbound direction at the crossing (veh/hr)*
BT_1 = *average blocked time for train crossing in the eastbound direction (sec)*

Expected Total Delay
The expected total delay is the expected number of crossing events multiplied by sum of the total vehicular crossing delay per train. For example:

$D_{1tot} = T_1 \times (D_{1w} + D_{1e})$

T_1 = *Expected one-train crossing events per hour (eastbound direction)*
D_{1w} = *Vehicular crossing delay per train for westbound or northbound vehicles (sec)*
D_{1e} = *Vehicular crossing delay per train for eastbound or southbound vehicles (sec)*

To estimate the total vehicle delay from all trains at a crossing ($\mathbf{D_{tot}}$), three values must be summed: eastbound trains, westbound trains, and simultaneous trains.

$D_{tot} = D_{1tot} + D_{2tot} + D_{12tot}$

Average Delay Per Vehicle
The average delay per vehicle is based on the total expected delay and the number of vehicles crossing at that location.

$D_{ave} = D_{tot} / (V_w + V_e)$

Average Blocked Time Per Train (sec)
The average blocked time per train is related to the total blocked time at a crossing divided by the number of trains at the crossing.

$BT_{ave} = (BT_{tot} \times 60 \text{ sec/min}) / ((F_1 + F_2) / 24 \text{ hours/day})$

BT_{tot} = *Total Average Blocked Time Per Hour for a Crossing (min/hr)*
F_1 = *Frequency of eastbound trains (trains per day)*
F_2 = *Frequency of westbound trains (trains per day)*

Average Delay Per Delayed Vehicle
The average delay per delayed vehicle is related to the total delay at the crossing divided by the number of queued (or delayed) vehicles.

$D_d = D_{tot} / Q_{tot}$

D_{tot} = *Total expected delay*
Q_{tot} = *Total vehicles queued or delayed per hour*

Appendix B:
Results of Operational Analysis
Gardner Existing Conditions

Synchro Analysis

1. 2008 Gardner Existing Conditions

HCS Analysis

1. 2008 Gardner Existing Conditions

2008 Gardner Existing - AM Peak Hour - Synchro Intersection LOS

1: 175th Street & Waverly Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	59	273	1	0	49	50	2	76	1	81	22	12
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	71	329	1	0	59	60	2	92	1	98	27	14
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	119			330			589	591	330	608	561	89
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	119			330			589	591	330	608	561	89
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.2	6.6	6.3
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.4
p0 queue free %	95			100			99	77	100	69	94	98
cM capacity (veh/h)	1450			1241			381	398	717	320	411	953

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	401	119	95	139
Volume Left	71	0	2	98
Volume Right	1	60	1	14
cSH	1450	1241	400	360
Volume to Capacity	0.05	0.00	0.24	0.39
Queue Length 95th (ft)	4	0	23	44
Control Delay (s)	1.7	0.0	16.8	21.1
Lane LOS	A		C	C
Approach Delay (s)	1.7	0.0	16.8	21.1
Approach LOS			C	C

Intersection Summary			
Average Delay	6.9		
Intersection Capacity Utilization	44.1%	ICU Level of Service	A
Analysis Period (min)	15		

2: US 56 & Gardner Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	37	522	58	91	200	98	68	300	179	133	192	21
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.99			0.96		1.00	0.94		1.00	0.99	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3392			3179		1805	1724		1719	1807	
Flt Permitted		0.90			0.65		0.61	1.00		0.30	1.00	
Satd. Flow (perm)		3054			2075		1153	1724		545	1807	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	43	600	67	105	230	113	78	345	206	153	221	24
RTOR Reduction (vph)	0	16	0	0	70	0	0	31	0	0	6	0
Lane Group Flow (vph)	0	694	0	0	378	0	78	520	0	153	239	0
Heavy Vehicles (%)	3%	5%	2%	8%	9%	6%	0%	4%	4%	5%	4%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		16.5			16.5		19.4	19.4		19.4	19.4	
Effective Green, g (s)		16.5			16.5		19.4	19.4		19.4	19.4	
Actuated g/C Ratio		0.35			0.35		0.41	0.41		0.41	0.41	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1059			719		470	703		222	736	
v/s Ratio Prot								c0.30			0.13	
v/s Ratio Perm		c0.23			0.18		0.07			0.28		
v/c Ratio		0.66			0.53		0.17	0.74		0.69	0.32	
Uniform Delay, d1		13.1			12.4		9.0	12.0		11.6	9.6	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.5			0.7		0.2	4.1		8.6	0.3	
Delay (s)		14.6			13.1		9.1	16.0		20.2	9.9	
Level of Service		B			B		A	B		C	A	
Approach Delay (s)		14.6			13.1			15.2			13.9	
Approach LOS		B			B			B			B	

Intersection Summary			
HCM Average Control Delay	14.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	47.6	Sum of lost time (s)	11.7
Intersection Capacity Utilization	83.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

3: US 56 & Elm

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	16	819	9	10	359	37	6	2	21	66	4	22
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			0.99		1.00	0.86		1.00	0.87	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3615			3467		1805	1724		1805	1671	
Flt Permitted		0.95			0.93		0.74	1.00		0.74	1.00	
Satd. Flow (perm)		3421			3242		1404	1724		1408	1671	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	17	881	10	11	386	40	6	2	23	71	4	24
RTOR Reduction (vph)	0	1	0	0	7	0	0	20	0	0	21	0
Lane Group Flow (vph)	0	907	0	0	430	0	6	5	0	71	7	0
Heavy Vehicles (%)	0%	5%	0%	0%	9%	0%	0%	0%	0%	0%	0%	5%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		35.9			35.9		6.1	6.1		6.1	6.1	
Effective Green, g (s)		35.9			35.9		6.1	6.1		6.1	6.1	
Actuated g/C Ratio		0.70			0.70		0.12	0.12		0.12	0.12	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2408			2282		168	206		168	200	
v/s Ratio Prot								0.00			0.00	
v/s Ratio Perm		c0.27			0.13		0.00			c0.05		
v/c Ratio		0.38			0.19		0.04	0.02		0.42	0.03	
Uniform Delay, d1		3.0			2.6		19.8	19.8		20.8	19.8	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.1			0.0		0.1	0.0		1.7	0.1	
Delay (s)		3.1			2.6		19.9	19.9		22.5	19.9	
Level of Service		A			A		B	B		C	B	
Approach Delay (s)		3.1			2.6			19.9			21.8	
Approach LOS		A			A			B			C	

Intersection Summary			
HCM Average Control Delay	4.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	51.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	50.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

4: US 56 & Mulberry

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	32	900	6	6	362	47	2	1	17	80	3	24
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			0.98		1.00	0.86		1.00	0.87	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3461			3283		1805	1469		1752	1588	
Flt Permitted		0.93			0.94		0.74	1.00		0.75	1.00	
Satd. Flow (perm)		3231			3102		1403	1469		1374	1588	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	34	968	6	6	389	51	2	1	18	86	3	26
RTOR Reduction (vph)	0	1	0	0	12	0	0	16	0	0	23	0
Lane Group Flow (vph)	0	1007	0	0	434	0	2	3	0	86	6	0
Heavy Vehicles (%)	6%	4%	0%	0%	8%	9%	0%	100%	6%	3%	0%	4%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		35.9			35.9		6.0	6.0		6.0	6.0	
Effective Green, g (s)		35.9			35.9		6.0	6.0		6.0	6.0	
Actuated g/C Ratio		0.71			0.71		0.12	0.12		0.12	0.12	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2279			2188		165	173		162	187	
v/s Ratio Prot								0.00			0.00	
v/s Ratio Perm		c0.31			0.14		0.00			c0.06		
v/c Ratio		0.44			0.20		0.01	0.02		0.53	0.03	
Uniform Delay, d1		3.2			2.6		19.8	19.8		21.1	19.9	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.1			0.0		0.0	0.0		3.3	0.1	
Delay (s)		3.3			2.6		19.9	19.9		24.4	20.0	
Level of Service		A			A		B	B		C	B	
Approach Delay (s)		3.3			2.6			19.9			23.3	
Approach LOS		A			A			B			C	

Intersection Summary			
HCM Average Control Delay	4.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	50.9	Sum of lost time (s)	9.0
Intersection Capacity Utilization	67.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

2008 Gardner Existing - AM Peak Hour - Synchro Intersection LOS

5: US 56 & Moonlight Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↱		↰	↑↱		↰	↑↱	
Volume (vph)	60	856	125	36	274	148	115	109	108	402	139	45
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5		5.5	5.5		5.5	5.5	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.95		1.00	0.93		1.00	0.96	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1752	3619	1568	1752	3190		1752	1691		1770	1773	
Flt Permitted	0.42	1.00	1.00	0.17	1.00		0.63	1.00		0.27	1.00	
Satd. Flow (perm)	768	3619	1568	310	3190		1164	1691		509	1773	
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	66	941	137	40	301	163	126	120	119	442	153	49
RTOR Reduction (vph)	0	0	45	0	59	0	0	35	0	0	10	0
Lane Group Flow (vph)	66	941	92	40	405	0	126	204	0	442	192	0
Heavy Vehicles (%)	3%	5%	3%	3%	10%	2%	3%	3%	5%	2%	3%	4%
Turn Type	pm+pt		Perm	pm+pt			pm+pt			pm+pt		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6			8			4		
Actuated Green, G (s)	35.9	30.5	30.5	32.3	28.7		22.9	14.4		34.6	20.6	
Effective Green, g (s)	35.9	30.5	30.5	32.3	28.7		22.9	14.4		34.6	20.6	
Actuated g/C Ratio	0.42	0.35	0.35	0.37	0.33		0.27	0.17		0.40	0.24	
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5		5.5	5.5		5.5	5.5	
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	2.0	
Lane Grp Cap (vph)	381	1281	555	176	1062		367	282		419	424	
v/s Ratio Prot	c0.01	c0.26		0.01	0.13		0.03	0.12		c0.18	0.11	
v/s Ratio Perm	0.06		0.06	0.08			0.06			c0.24		
v/c Ratio	0.17	0.73	0.17	0.23	0.38		0.34	0.72		1.05	0.45	
Uniform Delay, d1	15.4	24.3	19.1	18.3	22.0		25.0	34.0		22.2	28.0	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.1	1.9	0.1	0.2	0.1		0.2	7.6		59.2	0.3	
Delay (s)	15.4	26.2	19.2	18.5	22.0		25.2	41.6		81.4	28.3	
Level of Service	B	C	B	B	C		C	D		F	C	
Approach Delay (s)		24.8			21.8			35.9			64.7	
Approach LOS		C			C			D			E	

Intersection Summary			
HCM Average Control Delay	35.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	86.2	Sum of lost time (s)	11.0
Intersection Capacity Utilization	81.3%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

6: Old US 56 & US 56

AM Peak Hour

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations	↰	↱	↑↑	↱	↰	↑↑
Volume (veh/h)	37	10	1175	197	5	441
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	38	10	1211	203	5	455
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1449	606			1211	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1449	606			1211	
tC, single (s)	6.9	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	68	98			99	
cM capacity (veh/h)	120	445			583	

Direction, Lane #	NW 1	NW 2	NE 1	NE 2	NE 3	SW 1	SW 2	SW 3
Volume Total	38	10	606	606	203	5	227	227
Volume Left	38	0	0	0	0	5	0	0
Volume Right	0	10	0	0	203	0	0	0
cSH	120	445	1700	1700	1700	583	1700	1700
Volume to Capacity	0.32	0.02	0.36	0.36	0.12	0.01	0.13	0.13
Queue Length 95th (ft)	31	2	0	0	0	1	0	0
Control Delay (s)	48.5	13.3	0.0	0.0	0.0	11.2	0.0	0.0
Lane LOS	E	B				B		
Approach Delay (s)	41.0		0.0			0.1		
Approach LOS	E							

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	40.9%	ICU Level of Service	A
Analysis Period (min)	15		

7: US-56 & Cedar Niles

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰↰	↑↑	↱		↰↑	↱↱	↰	↑↱	
Volume (vph)	38	1206	89	220	1043	54	73	14	422	34	8	36
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00		1.00	0.88	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85	1.00	0.88	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1805	3725	1615	3433	3689	1615		1824	2842	1752	1589	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.73	1.00	0.69	1.00	
Satd. Flow (perm)	1805	3725	1615	3433	3689	1615		1381	2842	1279	1589	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	43	1355	100	247	1172	61	82	16	474	38	9	40
RTOR Reduction (vph)	0	0	54	0	0	27	0	0	0	0	31	0
Lane Group Flow (vph)	43	1355	46	247	1172	34	0	98	474	38	18	0
Heavy Vehicles (%)	0%	2%	0%	2%	3%	0%	0%	0%	0%	3%	0%	6%
Turn Type	Prot		Perm	Prot		Perm	Perm		Perm	Perm		
Protected Phases	5	2		1	6			8			4	
Permitted Phases			2			6	8		8	4		
Actuated Green, G (s)	4.3	37.0	37.0	10.2	42.9	42.9		17.1	17.1	17.1	17.1	
Effective Green, g (s)	4.3	37.0	37.0	10.2	42.9	42.9		17.1	17.1	17.1	17.1	
Actuated g/C Ratio	0.05	0.46	0.46	0.13	0.54	0.54		0.21	0.21	0.21	0.21	
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0	
Lane Grp Cap (vph)	97	1725	748	438	1981	867		296	608	274	340	
v/s Ratio Prot	0.02	c0.36		c0.07	0.32						0.01	
v/s Ratio Perm			0.03			0.02		0.07	c0.17	0.03		
v/c Ratio	0.44	0.79	0.06	0.56	0.59	0.04		0.33	0.78	0.14	0.05	
Uniform Delay, d1	36.6	18.1	11.9	32.8	12.6	8.7		26.6	29.6	25.4	25.0	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	1.2	2.2	0.0	1.0	0.3	0.0		0.2	5.7	0.1	0.0	
Delay (s)	37.8	20.3	11.9	33.8	12.9	8.8		26.8	35.4	25.5	25.0	
Level of Service	D	C	B	C	B	A		C	D	C	C	
Approach Delay (s)		20.3			16.2			33.9			25.2	
Approach LOS		C			B			C			C	

Intersection Summary			
HCM Average Control Delay	20.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	79.9	Sum of lost time (s)	15.6
Intersection Capacity Utilization	68.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

8: US-56 & I-35 SB Ramps

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↱		↰	↑↑					↰		↱
Volume (veh/h)	0	1621	41	22	445	0	0	0	0	51	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	0	1706	43	23	468	0	0	0	0	54	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		986										
pX, platoon unblocked				0.68			0.68	0.68	0.68	0.68	0.68	
vC, conflicting volume	468			1749			2008	2243	875	1368	2264	234
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	468			1151			1534	1880	0	587	1912	234
tC, single (s)	4.1			4.3			7.5	6.5	6.9	7.7	6.5	7.0
tC, 2 stage (s)												
tF (s)	2.2			2.3			3.5	4.0	3.3	3.6	4.0	3.3
p0 queue free %	100			94			100	100	100	78	100	100
cM capacity (veh/h)	1104			382			52	46	738	243	44	765

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	SB 1	SB 2
Volume Total	1138	612	23	234	234	54	0
Volume Left	0	0	23	0	0	54	0
Volume Right	0	43	0	0	0	0	0
cSH	1700	1700	382	1700	1700	243	1700
Volume to Capacity	0.67	0.36	0.06	0.14	0.14	0.22	0.00
Queue Length 95th (ft)	0	0	5	0	0	21	0
Control Delay (s)	0.0	0.0	15.0	0.0	0.0	24.0	0.0
Lane LOS			C			C	A
Approach Delay (s)	0.0		0.7			24.0	
Approach LOS						C	

Intersection Summary			
Average Delay	0.7		
Intersection Capacity Utilization	56.1%	ICU Level of Service	B
Analysis Period (min)	15		

2008 Gardner Existing - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2008 Gardner Existing
9: US-56 & I-35 NB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	329	0	0	326	118	141	3	83	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	0	374	0	0	370	134	160	3	94	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	505			374			559	878	187	720	811	252
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	505			374			559	878	187	720	811	252
tC, single (s)	4.1			4.1			7.7	6.5	7.0	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.6	4.0	3.4	3.5	4.0	3.3
p0 queue free %	100			100			60	99	88	100	100	100
cM capacity (veh/h)	1070			1196			399	289	814	279	316	753

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	187	187	247	258	258
Volume Left	0	0	0	0	160
Volume Right	0	0	0	134	94
cSH	1700	1700	1700	1700	487
Volume to Capacity	0.11	0.11	0.15	0.15	0.53
Queue Length 95th (ft)	0	0	0	0	76
Control Delay (s)	0.0	0.0	0.0	0.0	20.4
Lane LOS					C
Approach Delay (s)	0.0		0.0		20.4
Approach LOS					C

Intersection Summary			
Average Delay	4.6		
Intersection Capacity Utilization	86.5%	ICU Level of Service	E
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing
10: Sante Fe & Moonlight Road — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	244	62	41	87	116	184
Sign Control		Stop	Stop		Free	
Grade		0%	0%		0%	
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	262	67	44	94	125	198
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					TWLTL	
Median storage veh)					2	
Upstream signal (ft)					258	
pX, platoon unblocked						
vC, conflicting volume	464	348	447	0	0	
vC1, stage 1 conf vol	348	348	0			
vC2, stage 2 conf vol	116	0	447			
vCu, unblocked vol	464	348	447	0	0	
tC, single (s)	7.1	6.5	6.5	6.2	4.1	
tC, 2 stage (s)	6.1	5.5	5.5			
tF (s)	3.5	4.0	4.0	3.3	2.2	
p0 queue free %	51	88	91	91	92	
cM capacity (veh/h)	540	569	516	1085	1623	

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	329	138	323
Volume Left	262	0	125
Volume Right	0	94	198
cSH	546	801	1623
Volume to Capacity	0.60	0.17	0.08
Queue Length 95th (ft)	99	15	6
Control Delay (s)	21.1	10.4	3.3
Lane LOS	C	B	A
Approach Delay (s)	21.1	10.4	3.3
Approach LOS	C	B	

Intersection Summary			
Average Delay	11.9		
Intersection Capacity Utilization	52.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing
11: Waverly Road & US 56 — AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	14	0	6	4	9	57	238	0	1	73	11
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	18	0	8	5	11	72	301	0	1	92	14
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	561	554	301	556	547	99	106			301		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	561	554	301	556	547	99	106			301		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.3	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.4	2.2			2.2		
p0 queue free %	100	96	100	98	99	99	95			100		
cM capacity (veh/h)	415	421	743	414	425	932	1472			1271		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	18	24	373	108
Volume Left	0	8	72	1
Volume Right	0	11	0	14
cSH	421	566	1472	1271
Volume to Capacity	0.04	0.04	0.05	0.00
Queue Length 95th (ft)	3	3	4	0
Control Delay (s)	13.9	11.6	1.8	0.1
Lane LOS	B	B	A	A
Approach Delay (s)	13.9	11.6	1.8	0.1
Approach LOS	B	B		

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	35.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing
12: 183rd Street & Four Corners Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	2	4	3	1	5	4	6	7	1	3	5	2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2	4	3	1	5	4	7	8	1	3	5	2

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	10	11	15	11
Volume Left (vph)	2	1	7	3
Volume Right (vph)	3	4	1	2
Hadj (s)	-0.16	-0.22	0.04	-0.06
Departure Headway (s)	3.8	3.7	4.0	3.9
Degree Utilization, x	0.01	0.01	0.02	0.01
Capacity (veh/h)	931	949	883	913
Control Delay (s)	6.8	6.8	7.1	6.9
Approach Delay (s)	6.8	6.8	7.1	6.9
Approach LOS	A	A	A	A

Intersection Summary			
Delay	6.9		
HCM Level of Service	A		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

2008 Gardner Existing - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2008 Gardner Existing
13: 183rd Street & US 56 — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	2	6	0	8	9	1	0	295	6	0	78	1
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	3	8	0	10	11	1	0	373	8	0	99	1
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	484	480	99	480	477	377	100			381		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	484	480	99	480	477	377	100			381		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	98	100	98	98	100	100			100		
cM capacity (veh/h)	487	488	962	493	490	674	1505			1189		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	10	23	381	100
Volume Left	3	10	0	0
Volume Right	0	1	8	1
cSH	488	499	1505	1189
Volume to Capacity	0.02	0.05	0.00	0.00
Queue Length 95th (ft)	2	4	0	0
Control Delay (s)	12.5	12.6	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	12.5	12.6	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	25.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing
14: 183rd Street & Waverly Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	10	2	2	16	12	2	2	2	3	2	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	11	2	2	17	13	2	2	2	3	2	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	30			13			41	47	12	43	41	24
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	30			13			41	47	12	43	41	24
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	100	100	100
cM capacity (veh/h)	1595			1619			964	848	1075	959	853	1058

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	13	33	7	5
Volume Left	0	2	2	3
Volume Right	2	13	2	0
cSH	1595	1619	953	914
Volume to Capacity	0.00	0.00	0.01	0.01
Queue Length 95th (ft)	0	0	1	0
Control Delay (s)	0.0	0.5	8.8	9.0
Lane LOS		A	A	A
Approach Delay (s)	0.0	0.5	8.8	9.0
Approach LOS			A	A

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing
15: 183rd Street & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	36	12	77	104	14	87	22	391	41	29	325	14
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	40	13	87	117	16	98	25	439	46	33	365	16
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	813	973	190	853	958	243	381			485		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	813	973	190	853	958	243	381			485		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	81	94	90	45	94	87	98			97		
cM capacity (veh/h)	218	241	825	211	246	764	1189			1088		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	40	100	117	113	25	293	193	33	243	137
Volume Left	40	0	117	0	25	0	0	33	0	0
Volume Right	0	87	0	98	0	0	46	0	0	16
cSH	218	622	211	592	1189	1700	1700	1088	1700	1700
Volume to Capacity	0.19	0.16	0.55	0.19	0.02	0.17	0.11	0.03	0.14	0.08
Queue Length 95th (ft)	17	14	74	18	2	0	0	2	0	0
Control Delay (s)	25.2	11.9	41.3	12.5	8.1	0.0	0.0	8.4	0.0	0.0
Lane LOS	D	B	E	B	A			A		
Approach Delay (s)	15.7		27.1		0.4			0.7		
Approach LOS	C		D							

Intersection Summary			
Average Delay	6.9		
Intersection Capacity Utilization	37.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing
16: Four Corners Road & US 56 — AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	1	3	7	0	5	4	11	294	0	1	85	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	1	4	9	0	7	5	14	387	0	1	112	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	539	530	387	541	530	112	112			387		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	539	530	387	541	530	112	112			387		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	99	99	100	99	99	99			100		
cM capacity (veh/h)	445	452	666	442	452	947	1490			1183		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	14	12	401	113
Volume Left	1	0	14	1
Volume Right	9	5	0	0
cSH	567	589	1490	1183
Volume to Capacity	0.03	0.02	0.01	0.00
Queue Length 95th (ft)	2	2	1	0
Control Delay (s)	11.5	11.2	0.4	0.1
Lane LOS	B	B	A	A
Approach Delay (s)	11.5	11.2	0.4	0.1
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	32.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing

17: 191st Street & US 56

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	1	0	0	1	0	302	1	0	85	1
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	6	6	1	0	0	1	0	392	1	0	110	1
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	505	505	111	508	505	393	112			394		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	505	505	111	508	505	393	112			394		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	99	100	100	100	100	100			100		
cM capacity (veh/h)	480	473	948	473	473	660	1491			1176		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	14	1	394	112
Volume Left	6	0	0	0
Volume Right	1	1	1	1
cSH	499	660	1491	1176
Volume to Capacity	0.03	0.00	0.00	0.00
Queue Length 95th (ft)	2	0	0	0
Control Delay (s)	12.4	10.5	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	12.4	10.5	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	27.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing

18: 191st Street & Four Corners Road

AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	1	4	7	6	8	2
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1	4	8	7	9	2
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	30	11			14	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	30	11			14	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			99	
cM capacity (veh/h)	984	1076			1617	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	5	14	11
Volume Left	1	0	9
Volume Right	4	7	0
cSH	1056	1700	1617
Volume to Capacity	0.01	0.01	0.01
Queue Length 95th (ft)	0	0	0
Control Delay (s)	8.4	0.0	5.8
Lane LOS	A		A
Approach Delay (s)	8.4	0.0	5.8
Approach LOS	A		

Intersection Summary			
Average Delay	3.6		
Intersection Capacity Utilization	17.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing

19: 191st Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	2	19	1	1	7	3	1	1	1	3	1	2
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2	21	1	1	8	3	1	1	1	3	1	2
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	11			22			40	39	21	39	38	9
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	11			22			40	39	21	39	38	9
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	100	100	100
cM capacity (veh/h)	1622			1607			965	856	1062	968	857	1078

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	24	12	3	7
Volume Left	2	1	1	3
Volume Right	1	3	1	2
cSH	1622	1607	954	980
Volume to Capacity	0.00	0.00	0.00	0.01
Queue Length 95th (ft)	0	0	0	1
Control Delay (s)	0.7	0.7	8.8	8.7
Lane LOS	A	A	A	A
Approach Delay (s)	0.7	0.7	8.8	8.7
Approach LOS			A	A

Intersection Summary			
Average Delay	2.4		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing

20: W 191st Street & Gardner Rd

AM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	6	38	12	230	458	2
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	6	40	13	242	482	2
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	749	482	484			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	749	482	484			
tC, single (s)	6.4	6.2	4.2			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.3			
p0 queue free %	98	93	99			
cM capacity (veh/h)	378	582	1048			

Direction, Lane #	EB 1	NB 1	SB 1	SB 2
Volume Total	46	255	482	2
Volume Left	6	13	0	0
Volume Right	40	0	0	2
cSH	542	1048	1700	1700
Volume to Capacity	0.09	0.01	0.28	0.00
Queue Length 95th (ft)	7	1	0	0
Control Delay (s)	12.3	0.5	0.0	0.0
Lane LOS	B	A		
Approach Delay (s)	12.3	0.5	0.0	
Approach LOS	B			

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	34.1%	ICU Level of Service	A
Analysis Period (min)	15		

2008 Gardner Existing - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2008 Gardner Existing
21: I-35 SB Ramps & Gardner Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	35	0	59	11	183	0	0	457	39
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	0	0	0	37	0	63	12	195	0	0	486	41
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	788	725	507	725	746	195	528			195		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	788	725	507	725	746	195	528			195		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.4	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.4	2.2			2.2		
p0 queue free %	100	100	100	89	100	92	99			100		
cM capacity (veh/h)	285	350	570	329	341	815	1050			1390		

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	100	206	528
Volume Left	37	12	0
Volume Right	63	0	41
cSH	526	1050	1700
Volume to Capacity	0.19	0.01	0.31
Queue Length 95th (ft)	17	1	0
Control Delay (s)	13.5	0.6	0.0
Lane LOS	B	A	
Approach Delay (s)	13.5	0.6	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	38.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing
22: I-35 NB Ramps & Gardner Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	73	0	13	0	0	0	0	121	169	385	107	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	80	0	14	0	0	0	0	133	186	423	118	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1190	1282	118	1204	1190	226	118			319		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1190	1282	118	1204	1190	226	118			319		
tC, single (s)	7.1	6.5	6.3	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.4	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	34	100	98	100	100	100	100			66		
cM capacity (veh/h)	122	110	918	118	125	819	1483			1241		

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	95	319	541
Volume Left	80	0	423
Volume Right	14	186	0
cSH	140	1700	1241
Volume to Capacity	0.68	0.19	0.34
Queue Length 95th (ft)	94	0	38
Control Delay (s)	72.3	0.0	8.1
Lane LOS	F		A
Approach Delay (s)	72.3	0.0	8.1
Approach LOS	F		

Intersection Summary			
Average Delay	11.8		
Intersection Capacity Utilization	58.5%	ICU Level of Service	B
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing
23: E 191st Street & Gardner Rd — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	5	285	0	1	119
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	5	306	0	1	128
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	437	306			306	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	437	306			306	
tC, single (s)	6.4	6.2			5.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			3.1	
p0 queue free %	100	99			100	
cM capacity (veh/h)	580	738			856	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	5	306	129
Volume Left	0	0	1
Volume Right	5	0	0
cSH	738	1700	856
Volume to Capacity	0.01	0.18	0.00
Queue Length 95th (ft)	1	0	0
Control Delay (s)	9.9	0.0	0.1
Lane LOS	A		A
Approach Delay (s)	9.9	0.0	0.1
Approach LOS	A		

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	25.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing
24: Sunflower Road & US 56 — AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	3	1	5	26	0	0	5	300	52	1	81	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	4	1	6	33	0	0	6	380	66	1	103	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	530	563	103	537	530	413	103			446		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	530	563	103	537	530	413	103			446		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	100	99	93	100	100	100			100		
cM capacity (veh/h)	461	436	958	446	455	644	1502			1125		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	11	33	452	104
Volume Left	4	33	6	1
Volume Right	6	0	66	0
cSH	642	446	1502	1125
Volume to Capacity	0.02	0.07	0.00	0.00
Queue Length 95th (ft)	1	6	0	0
Control Delay (s)	10.7	13.7	0.1	0.1
Lane LOS	B	B	A	A
Approach Delay (s)	10.7	13.7	0.1	0.1
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	32.2%	ICU Level of Service	A
Analysis Period (min)	15		

2008 Gardner Existing - AM Peak Hour - Synchro Intersection LOS

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	331	46	7	105	12	26
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	424	59	9	135	15	33
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			483		606	454
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			483		606	454
tC, single (s)			4.2		6.5	6.2
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.3
p0 queue free %			99		97	94
cM capacity (veh/h)			1020		446	602

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	483	144	49
Volume Left	0	9	15
Volume Right	59	0	33
cSH	1700	1020	542
Volume to Capacity	0.28	0.01	0.09
Queue Length 95th (ft)	0	1	7
Control Delay (s)	0.0	0.6	12.3
Lane LOS		A	B
Approach Delay (s)	0.0	0.6	12.3
Approach LOS			B

Intersection Summary			
Average Delay	1.0		
Intersection Capacity Utilization	30.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	1	60	26	12	2	0
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	1	71	31	14	2	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	45				112	38
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	45				112	38
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	100
cM capacity (veh/h)	1576				889	1040

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	73	45	2
Volume Left	1	0	2
Volume Right	0	14	0
cSH	1576	1700	889
Volume to Capacity	0.00	0.03	0.00
Queue Length 95th (ft)	0	0	0
Control Delay (s)	0.1	0.0	9.1
Lane LOS	A		A
Approach Delay (s)	0.1	0.0	9.1
Approach LOS			A

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	14.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	58	20	6	3	20	39	5	220	7	25	53	32
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	65	22	7	3	22	44	6	247	8	28	60	36

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	94	70	261	124
Volume Left (vph)	65	3	6	28
Volume Right (vph)	7	44	8	36
Hadj (s)	0.14	-0.34	0.03	-0.10
Departure Headway (s)	5.0	4.6	4.5	4.5
Degree Utilization, x	0.13	0.09	0.33	0.16
Capacity (veh/h)	657	708	770	750
Control Delay (s)	8.8	8.0	9.6	8.3
Approach Delay (s)	8.8	8.0	9.6	8.3
Approach LOS	A	A	A	A

Intersection Summary			
Delay	9.0		
HCM Level of Service	A		
Intersection Capacity Utilization	37.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	335	1343	0	467	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	376	1509	0	525	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			1885		639	188
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1885		639	188
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			322		413	828

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	188	188	1509	262	262
Volume Left	0	0	0	0	0
Volume Right	0	0	1509	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.11	0.11	0.89	0.15	0.15
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	86.5%	ICU Level of Service	E
Analysis Period (min)	15		

2008 Gardner Existing - PM Peak Hour - Synchro Intersection LOS

1: 175th Street & Waverly Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	12	85	2	1	267	77	8	18	1	29	20	20
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	14	98	2	1	307	89	9	21	1	33	23	23
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	395			100			514	524	99	491	481	351
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	395			100			514	524	99	491	481	351
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			100			98	95	100	93	95	97
cM capacity (veh/h)	1163			1505			433	452	962	465	478	692

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	114	397	31	79
Volume Left	14	1	9	33
Volume Right	2	89	1	23
cSH	1163	1505	455	519
Volume to Capacity	0.01	0.00	0.07	0.15
Queue Length 95th (ft)	1	0	5	13
Control Delay (s)	1.1	0.0	13.5	13.2
Lane LOS	A	A	B	B
Approach Delay (s)	1.1	0.0	13.5	13.2
Approach LOS			B	B

Intersection Summary			
Average Delay	2.6		
Intersection Capacity Utilization	31.5%	ICU Level of Service	A
Analysis Period (min)	15		

2: US 56 & Gardner Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	21	254	48	202	592	208	54	143	134	133	138	37
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.98			0.97		1.00	0.93		1.00	0.97	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3297			3389		1770	1694		1736	1777	
Flt Permitted		0.86			0.79		0.64	1.00		0.53	1.00	
Satd. Flow (perm)		2859			2699		1193	1694		973	1777	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	22	270	51	215	630	221	57	152	143	141	147	39
RTOR Reduction (vph)	0	24	0	0	39	0	0	60	0	0	17	0
Lane Group Flow (vph)	0	319	0	0	1027	0	57	235	0	141	169	0
Heavy Vehicles (%)	2%	8%	2%	1%	3%	1%	2%	4%	4%	4%	4%	2%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		23.5			23.5		13.6	13.6		13.6	13.6	
Effective Green, g (s)		23.5			23.5		13.6	13.6		13.6	13.6	
Actuated g/C Ratio		0.48			0.48		0.28	0.28		0.28	0.28	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1377			1300		332	472		271	495	
v/s Ratio Prot								0.14			0.10	
v/s Ratio Perm		0.11			c0.38		0.05			c0.14		
v/c Ratio		0.23			0.79		0.17	0.50		0.52	0.34	
Uniform Delay, d1		7.4			10.6		13.3	14.7		14.8	14.0	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.1			3.3		0.2	0.8		1.8	0.4	
Delay (s)		7.5			13.9		13.6	15.6		16.6	14.4	
Level of Service		A			B		B	B		B	B	
Approach Delay (s)		7.5			13.9			15.2			15.4	
Approach LOS		A			B			B			B	

Intersection Summary			
HCM Average Control Delay	13.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	48.8	Sum of lost time (s)	11.7
Intersection Capacity Utilization	81.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

3: US 56 & Elm

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	5	531	20	32	976	33	19	5	42	57	10	26
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.99			1.00		1.00	0.87		1.00	0.89	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3606			3703		1703	1616		1770	1692	
Flt Permitted		0.95			0.93		0.73	1.00		0.73	1.00	
Satd. Flow (perm)		3419			3445		1314	1616		1352	1692	
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	5	542	20	33	996	34	19	5	43	58	10	27
RTOR Reduction (vph)	0	2	0	0	2	0	0	38	0	0	24	0
Lane Group Flow (vph)	0	565	0	0	1061	0	19	10	0	58	13	0
Heavy Vehicles (%)	0%	5%	0%	3%	2%	0%	6%	0%	2%	2%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		34.7			34.7		5.9	5.9		5.9	5.9	
Effective Green, g (s)		34.7			34.7		5.9	5.9		5.9	5.9	
Actuated g/C Ratio		0.70			0.70		0.12	0.12		0.12	0.12	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2392			2410		156	192		161	201	
v/s Ratio Prot								0.01			0.01	
v/s Ratio Perm		0.17			c0.31		0.01			c0.04		
v/c Ratio		0.24			0.44		0.12	0.05		0.36	0.07	
Uniform Delay, d1		2.7			3.2		19.5	19.4		20.1	19.4	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.1			0.1		0.4	0.1		1.4	0.1	
Delay (s)		2.7			3.4		19.9	19.5		21.5	19.5	
Level of Service		A			A		B	B		C	B	
Approach Delay (s)		2.7			3.4			19.6			20.7	
Approach LOS		A			A			B			C	

Intersection Summary			
HCM Average Control Delay	4.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	49.6	Sum of lost time (s)	9.0
Intersection Capacity Utilization	66.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

4: US 56 & Mulberry

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	11	624	4	23	1059	29	6	2	14	35	5	13
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			1.00		1.00	0.87		1.00	0.89	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3436			3525		1805	1555		1805	1694	
Flt Permitted		0.94			0.94		1.00	1.00		1.00	1.00	
Satd. Flow (perm)		3218			3311		1900	1555		1900	1694	
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	11	637	4	23	1081	30	6	2	14	36	5	13
RTOR Reduction (vph)	0	1	0	0	2	0	0	13	0	0	12	0
Lane Group Flow (vph)	0	652	0	0	1132	0	6	3	0	36	6	0
Heavy Vehicles (%)	0%	5%	0%	0%	2%	0%	0%	0%	7%	0%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		36.3			36.3		3.1	3.1		3.1	3.1	
Effective Green, g (s)		36.3			36.3		3.1	3.1		3.1	3.1	
Actuated g/C Ratio		0.75			0.75		0.06	0.06		0.06	0.06	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2414			2483		122	100		122	109	
v/s Ratio Prot								0.00			0.00	
v/s Ratio Perm		0.20			c0.34		0.00			c0.02		
v/c Ratio		0.27			0.46		0.05	0.03		0.30	0.05	
Uniform Delay, d1		1.9			2.3		21.3	21.2		21.6	21.3	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.1			0.1		0.2	0.1		1.4	0.2	
Delay (s)		2.0			2.4		21.4	21.4		23.0	21.5	
Level of Service		A			A		C	C		C	C	
Approach Delay (s)		2.0			2.4			21.4			22.5	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	3.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	48.4	Sum of lost time (s)	9.0
Intersection Capacity Utilization	62.8%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

2008 Gardner Existing - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2008 Gardner Existing
5: US 56 & Moonlight Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	107	374	205	159	882	491	124	154	50	233	200	87
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5		5.5	5.5		5.5	5.5	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.95		1.00	0.96		1.00	0.95	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1752	3585	1583	1770	3349		1770	1794		1770	1778	
Flt Permitted	0.12	1.00	1.00	0.47	1.00		0.34	1.00		0.34	1.00	
Satd. Flow (perm)	226	3585	1583	868	3349		631	1794		626	1778	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	116	407	223	173	959	534	135	167	54	253	217	95
RTOR Reduction (vph)	0	0	146	0	60	0	0	12	0	0	13	0
Lane Group Flow (vph)	116	407	77	173	1433	0	135	209	0	253	299	0
Heavy Vehicles (%)	3%	6%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Turn Type	pm+pt		Perm	pm+pt			pm+pt			pm+pt		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6			8			4		
Actuated Green, G (s)	41.2	32.6	32.6	43.6	33.8		25.6	16.2		32.8	19.8	
Effective Green, g (s)	41.2	32.6	32.6	43.6	33.8		25.6	16.2		32.8	19.8	
Actuated g/C Ratio	0.44	0.34	0.34	0.46	0.36		0.27	0.17		0.35	0.21	
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5		5.5	5.5		5.5	5.5	
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	2.0	
Lane Grp Cap (vph)	237	1235	546	493	1197		284	307		374	372	
v/s Ratio Prot	c0.04	0.11		0.04	c0.43		0.05	0.12		c0.09	c0.17	
v/s Ratio Perm	0.17		0.05	0.13			0.08			0.14		
v/c Ratio	0.49	0.33	0.14	0.35	1.20		0.48	0.68		0.68	0.80	
Uniform Delay, d1	20.8	22.9	21.4	15.3	30.4		27.5	36.8		24.1	35.5	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.6	0.1	0.0	0.2	96.9		0.5	4.9		3.8	11.2	
Delay (s)	21.3	23.0	21.4	15.5	127.3		28.0	41.7		27.9	46.7	
Level of Service	C	C	C	B	F		C	D		C	D	
Approach Delay (s)		22.2			115.7			36.5			38.3	
Approach LOS		C			F			D			D	

Intersection Summary			
HCM Average Control Delay	73.2	HCM Level of Service	E
HCM Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	94.6	Sum of lost time (s)	16.5
Intersection Capacity Utilization	89.3%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2008 Gardner Existing
6: Old US 56 & US 56 — PM Peak Hour

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Volume (veh/h)	100	20	565	90	9	1434
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	109	22	614	98	10	1559
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1413	307			614	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1413	307			614	
tC, single (s)	6.9	7.0			4.2	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	13	97			99	
cM capacity (veh/h)	125	683			948	

Direction, Lane #	NW 1	NW 2	NE 1	NE 2	NE 3	SW 1	SW 2	SW 3
Volume Total	109	22	307	307	98	10	779	779
Volume Left	109	0	0	0	0	10	0	0
Volume Right	0	22	0	0	98	0	0	0
cSH	125	683	1700	1700	1700	948	1700	1700
Volume to Capacity	0.87	0.03	0.18	0.18	0.06	0.01	0.46	0.46
Queue Length 95th (ft)	136	2	0	0	0	1	0	0
Control Delay (s)	114.3	10.4	0.0	0.0	0.0	8.8	0.0	0.0
Lane LOS	F	B				A		
Approach Delay (s)	97.0		0.0			0.1		
Approach LOS	F							

Intersection Summary			
Average Delay	5.3		
Intersection Capacity Utilization	49.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing
7: US-56 & 174th St — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	34	1083	148	427	1115	31	112	12	331	30	8	23
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00		1.00	0.88	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85	1.00	0.89	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1805	3689	1599	3502	3689	1615		1818	2842	1805	1688	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.72	1.00	0.67	1.00	
Satd. Flow (perm)	1805	3689	1599	3502	3689	1615		1370	2842	1272	1688	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	38	1203	164	474	1239	34	124	13	368	33	9	26
RTOR Reduction (vph)	0	0	95	0	0	15	0	0	0	0	21	0
Lane Group Flow (vph)	38	1203	69	474	1239	19	0	137	368	33	14	0
Heavy Vehicles (%)	0%	3%	1%	0%	3%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Prot		Perm	Prot		Perm	Perm		Perm	Perm		
Protected Phases	5	2		1	6			8			4	
Permitted Phases			2			6	8		8	4		
Actuated Green, G (s)	4.4	29.6	29.6	11.3	36.5	36.5		13.6	13.6	13.6	13.6	
Effective Green, g (s)	4.4	29.6	29.6	11.3	36.5	36.5		13.6	13.6	13.6	13.6	
Actuated g/C Ratio	0.06	0.42	0.42	0.16	0.52	0.52		0.19	0.19	0.19	0.19	
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0	
Lane Grp Cap (vph)	113	1558	675	565	1921	841		266	551	247	327	
v/s Ratio Prot	0.02	c0.33		c0.14	0.34						0.01	
v/s Ratio Perm			0.04			0.01		0.10	c0.13	0.03		
v/c Ratio	0.34	0.77	0.10	0.84	0.64	0.02		0.52	0.67	0.13	0.04	
Uniform Delay, d1	31.5	17.4	12.2	28.5	12.1	8.1		25.3	26.2	23.4	23.0	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.6	2.2	0.0	10.1	0.6	0.0		0.7	2.4	0.1	0.0	
Delay (s)	32.1	19.6	12.3	38.6	12.7	8.2		26.0	28.5	23.5	23.0	
Level of Service	C	B	B	D	B	A		C	C	C	C	
Approach Delay (s)		19.1			19.6			27.8			23.2	
Approach LOS		B			B			C			C	

Intersection Summary			
HCM Average Control Delay	20.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	70.1	Sum of lost time (s)	15.6
Intersection Capacity Utilization	67.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2008 Gardner Existing
8: US-56 & I-35 SB Ramps — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	1247	196	96	437	0	0	0	0	114	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	1341	211	103	470	0	0	0	0	123	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		986										
pX, platoon unblocked				0.71			0.71	0.71	0.71	0.71	0.71	
vC, conflicting volume	470			1552			1888	2123	776	1347	2228	235
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	470			947			1423	1756	0	656	1905	235
tC, single (s)	4.1			4.2			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			79			100	100	100	41	100	100
cM capacity (veh/h)	1102			496			58	48	769	208	39	767

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	SB 1	SB 2
Volume Total	894	658	103	235	235	123	0
Volume Left	0	0	103	0	0	123	0
Volume Right	0	211	0	0	0	0	0
cSH	1700	1700	496	1700	1700	208	1700
Volume to Capacity	0.53	0.39	0.21	0.14	0.14	0.59	0.00
Queue Length 95th (ft)	0	0	19	0	0	82	0
Control Delay (s)	0.0	0.0	14.2	0.0	0.0	44.6	0.0
Lane LOS			B			E	A
Approach Delay (s)	0.0		2.6			44.6	
Approach LOS						E	

Intersection Summary			
Average Delay	3.1		
Intersection Capacity Utilization	62.4%	ICU Level of Service	B
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing

9: US-56 & I-35 NB Ramps

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	437	0	0	462	18	71	2	34	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	0	497	0	0	525	20	81	2	39	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	545			497			759	1042	248	823	1032	273
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	545			497			759	1042	248	823	1032	273
tC, single (s)	4.1			4.1			7.6	6.5	7.2	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.6	4.0	3.4	3.5	4.0	3.3
p0 queue free %	100			100			72	99	95	100	100	100
cM capacity (veh/h)	1034			1078			287	232	714	252	235	731

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	248	248	350	195	122
Volume Left	0	0	0	0	81
Volume Right	0	0	0	20	39
cSH	1700	1700	1700	1700	352
Volume to Capacity	0.15	0.15	0.21	0.11	0.35
Queue Length 95th (ft)	0	0	0	0	38
Control Delay (s)	0.0	0.0	0.0	0.0	20.5
Lane LOS					C
Approach Delay (s)	0.0		0.0		20.5
Approach LOS					C

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	60.5%	ICU Level of Service	B
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing

10: Moonlight Road & Sante Fe

PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	225	54	88	104	129	436
Sign Control		Stop	Stop		Free	
Grade		0%	0%		0%	
Peak Hour Factor	0.80	0.80	0.80	0.80	0.80	0.80
Hourly flow rate (vph)	281	68	110	130	161	545
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)					249	
pX, platoon unblocked						
vC, conflicting volume	780	595	868	0	0	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	780	595	868	0	0	
tC, single (s)	7.1	6.5	6.5	6.2	4.1	
tC, 2 stage (s)						
tF (s)	3.5	4.0	4.0	3.3	2.2	
p0 queue free %	0	82	58	88	90	
cM capacity (veh/h)	172	376	262	1085	1623	

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	349	240	706
Volume Left	281	0	161
Volume Right	0	130	545
cSH	192	444	1623
Volume to Capacity	1.82	0.54	0.10
Queue Length 95th (ft)	621	78	8
Control Delay (s)	428.5	22.2	2.5
Lane LOS	F	C	A
Approach Delay (s)	428.5	22.2	2.5
Approach LOS	F	C	

Intersection Summary			
Average Delay	120.9		
Intersection Capacity Utilization	70.3%	ICU Level of Service	C
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing

11: Waverly Road & US 56

PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	11	3	7	3	12	15	112	0	2	248	1
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	0	12	3	8	3	14	17	127	0	2	282	1
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	464	449	127	458	448	282	283			127		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	464	449	127	458	448	282	283			127		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.3	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.4	2.2			2.2		
p0 queue free %	100	97	100	98	99	98	99			100		
cM capacity (veh/h)	494	498	928	477	497	742	1279			1471		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	16	25	144	285
Volume Left	0	8	17	2
Volume Right	3	14	0	1
cSH	553	596	1279	1471
Volume to Capacity	0.03	0.04	0.01	0.00
Queue Length 95th (ft)	2	3	1	0
Control Delay (s)	11.7	11.3	1.0	0.1
Lane LOS	B	B	A	A
Approach Delay (s)	11.7	11.3	1.0	0.1
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	30.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing

12: 183rd Street & Four Corners Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	1	4	2	0	4	4	2	2	0	2	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1	4	2	0	4	4	2	2	0	2	2	1

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	8	9	4	5
Volume Left (vph)	1	0	2	2
Volume Right (vph)	2	4	0	1
Hadj (s)	-0.14	-0.25	0.10	-0.04
Departure Headway (s)	3.8	3.7	4.0	3.9
Degree Utilization, x	0.01	0.01	0.00	0.01
Capacity (veh/h)	941	970	874	914
Control Delay (s)	6.8	6.7	7.1	6.9
Approach Delay (s)	6.8	6.7	7.1	6.9
Approach LOS	A	A	A	A

Intersection Summary			
Delay	6.8		
HCM Level of Service	A		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

2008 Gardner Existing - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2008 Gardner Existing
13: 183rd Street & US 56 — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✣			✣			✣			✣	
Volume (veh/h)	2	4	0	5	8	0	0	134	12	0	256	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	2	4	0	5	8	0	0	141	13	0	269	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	421	423	269	419	417	147	269			154		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	421	423	269	419	417	147	269			154		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	99	100	99	98	100	100			100		
cM capacity (veh/h)	540	521	774	545	525	905	1306			1439		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	6	14	154	269
Volume Left	2	5	0	0
Volume Right	0	0	13	0
cSH	527	532	1306	1439
Volume to Capacity	0.01	0.03	0.00	0.00
Queue Length 95th (ft)	1	2	0	0
Control Delay (s)	11.9	11.9	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	11.9	11.9	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	23.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing
14: 183rd Street & Waverly Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✣			✣			✣			✣	
Volume (veh/h)	0	14	2	2	10	12	1	2	2	1	2	2
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	15	2	2	11	13	1	2	2	1	2	2
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	24			17			41	45	16	41	39	17
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	24			17			41	45	16	41	39	17
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	100	100	100
cM capacity (veh/h)	1604			1613			962	850	1069	962	856	1067

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	17	26	5	5
Volume Left	0	2	1	1
Volume Right	2	13	2	2
cSH	1604	1613	950	952
Volume to Capacity	0.00	0.00	0.01	0.01
Queue Length 95th (ft)	0	0	0	0
Control Delay (s)	0.0	0.6	8.8	8.8
Lane LOS		A	A	A
Approach Delay (s)	0.0	0.6	8.8	8.8
Approach LOS			A	A

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing
15: 183rd Street & Gardner Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Volume (veh/h)	28	22	26	48	31	42	65	256	99	57	227	37
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	29	23	27	51	33	44	68	269	104	60	239	39
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	711	889	139	737	856	187	278			374		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	711	889	139	737	856	187	278			374		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	88	91	97	80	88	95	95			95		
cM capacity (veh/h)	254	252	884	255	264	823	1282			1181		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	29	51	51	77	68	180	194	60	159	119
Volume Left	29	0	51	0	68	0	0	60	0	0
Volume Right	0	27	0	44	0	0	104	0	0	39
cSH	254	412	255	433	1282	1700	1700	1181	1700	1700
Volume to Capacity	0.12	0.12	0.20	0.18	0.05	0.11	0.11	0.05	0.09	0.07
Queue Length 95th (ft)	10	10	18	16	4	0	0	4	0	0
Control Delay (s)	21.1	15.0	22.6	15.1	8.0	0.0	0.0	8.2	0.0	0.0
Lane LOS	C	B	C	C	A			A		
Approach Delay (s)	17.2		18.1		1.2			1.5		
Approach LOS	C		C							

Intersection Summary			
Average Delay	4.8		
Intersection Capacity Utilization	32.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing
16: Four Corners Road & US 56 — PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✣			✣			✣			✣	
Volume (veh/h)	2	1	1	0	1	3	3	144	1	4	265	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	2	1	1	0	1	3	3	162	1	4	298	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	480	476	162	478	476	298	298			163		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	480	476	162	478	476	298	298			163		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	100	100	100	100			100		
cM capacity (veh/h)	494	488	888	498	488	739	1258			1410		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	4	4	166	302
Volume Left	2	0	3	4
Volume Right	1	3	1	0
cSH	554	655	1258	1410
Volume to Capacity	0.01	0.01	0.00	0.00
Queue Length 95th (ft)	1	1	0	0
Control Delay (s)	11.6	10.5	0.2	0.1
Lane LOS	B	B	A	A
Approach Delay (s)	11.6	10.5	0.2	0.1
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	26.0%	ICU Level of Service	A
Analysis Period (min)	15		

2008 Gardner Existing - PM Peak Hour - Synchro Intersection LOS

17: 191st Street & US 56

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	0	0	2	3	0	0	141	0	0	267	4
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	0	0	0	2	3	0	0	162	0	0	307	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	473	471	309	471	474	162	311			162		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	473	471	309	471	474	162	311			162		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	100	99	100	100			100		
cM capacity (veh/h)	502	494	736	506	488	888	1260			1429		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	0	6	162	311
Volume Left	0	2	0	0
Volume Right	0	0	0	5
cSH	1700	495	1260	1429
Volume to Capacity	0.00	0.01	0.00	0.00
Queue Length 95th (ft)	0	1	0	0
Control Delay (s)	0.0	12.4	0.0	0.0
Lane LOS	A	B		
Approach Delay (s)	0.0	12.4	0.0	0.0
Approach LOS	A	B		

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	24.3%	ICU Level of Service	A
Analysis Period (min)	15		

18: 191st Street & Four Corners Road

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	5	5	3	2	2	3
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	3	2	2	3
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	12	4			5	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	12	4			5	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	99			100	
cM capacity (veh/h)	1006	1085			1629	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	11	5	5
Volume Left	5	0	2
Volume Right	5	2	0
cSH	1044	1700	1629
Volume to Capacity	0.01	0.00	0.00
Queue Length 95th (ft)	1	0	0
Control Delay (s)	8.5	0.0	2.9
Lane LOS	A		A
Approach Delay (s)	8.5	0.0	2.9
Approach LOS	A		

Intersection Summary			
Average Delay	5.0		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

19: 191st Street & Waverly Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	1	3	0	2	9	6	1	1	1	4	1	1
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1	3	0	2	10	7	1	1	1	4	1	1
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	16			3			24	26	3	24	23	13
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	16			3			24	26	3	24	23	13
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	100	100	100
cM capacity (veh/h)	1614			1632			988	869	1086	981	873	1073

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	4	18	3	7
Volume Left	1	2	1	4
Volume Right	0	7	1	1
cSH	1614	1632	973	975
Volume to Capacity	0.00	0.00	0.00	0.01
Queue Length 95th (ft)	0	0	0	1
Control Delay (s)	1.8	0.9	8.7	8.7
Lane LOS	A	A	A	A
Approach Delay (s)	1.8	0.9	8.7	8.7
Approach LOS			A	A

Intersection Summary			
Average Delay	3.3		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

20: W 191st Street & Gardner Rd

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	11	44	30	479	361	10
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	12	49	33	532	401	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1000	401	412			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1000	401	412			
tC, single (s)	6.4	6.3	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.4	2.2			
p0 queue free %	95	92	97			
cM capacity (veh/h)	264	638	1141			

Direction, Lane #	EB 1	NB 1	SB 1	SB 2
Volume Total	61	566	401	11
Volume Left	12	33	0	0
Volume Right	49	0	0	11
cSH	497	1141	1700	1700
Volume to Capacity	0.12	0.03	0.24	0.01
Queue Length 95th (ft)	10	2	0	0
Control Delay (s)	13.3	0.8	0.0	0.0
Lane LOS	B	A		
Approach Delay (s)	13.3	0.8	0.0	
Approach LOS	B			

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	59.2%	ICU Level of Service	B
Analysis Period (min)	15		

2008 Gardner Existing - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2008 Gardner Existing
21: I-35 SB Ramps & Gardner Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	138	0	370	8	139	0	0	326	79
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	150	0	402	9	151	0	0	354	86
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	968	566	397	566	609	151	440			151		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	968	566	397	566	609	151	440			151		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.2			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.3			2.2		
p0 queue free %	100	100	100	65	100	55	99			100		
cM capacity (veh/h)	128	433	657	429	409	887	1064			1442		

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	552	160	440
Volume Left	150	9	0
Volume Right	402	0	86
cSH	688	1064	1700
Volume to Capacity	0.80	0.01	0.26
Queue Length 95th (ft)	205	1	0
Control Delay (s)	28.0	0.5	0.0
Lane LOS	D	A	
Approach Delay (s)	28.0	0.5	0.0
Approach LOS	D		

Intersection Summary			
Average Delay	13.5		
Intersection Capacity Utilization	59.1%	ICU Level of Service	B
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing
22: I-35 NB Ramps & Gardner Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	37	4	14	0	0	0	0	110	38	201	263	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	42	5	16	0	0	0	0	125	43	228	299	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	902	924	299	920	902	147	299			168		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	902	924	299	920	902	147	299			168		
tC, single (s)	7.2	6.5	6.3	7.1	6.5	6.2	4.1			4.2		
tC, 2 stage (s)												
tF (s)	3.6	4.0	3.4	3.5	4.0	3.3	2.2			2.3		
p0 queue free %	81	98	98	100	100	100	100			84		
cM capacity (veh/h)	220	227	729	213	233	906	1274			1386		

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	62	168	527
Volume Left	42	0	228
Volume Right	16	43	0
cSH	269	1700	1386
Volume to Capacity	0.23	0.10	0.16
Queue Length 95th (ft)	22	0	15
Control Delay (s)	22.4	0.0	4.4
Lane LOS	C		A
Approach Delay (s)	22.4	0.0	4.4
Approach LOS	C		

Intersection Summary			
Average Delay	4.9		
Intersection Capacity Utilization	46.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing
23: E 191st Street & Gardner Rd — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	2	146	1	6	271
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	0	2	154	1	6	285
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	452	154			155	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	452	154			155	
tC, single (s)	6.4	6.7			4.3	
tC, 2 stage (s)						
tF (s)	3.5	3.8			2.4	
p0 queue free %	100	100			100	
cM capacity (veh/h)	566	780			1339	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	2	155	292
Volume Left	0	0	6
Volume Right	2	1	0
cSH	780	1700	1339
Volume to Capacity	0.00	0.09	0.00
Queue Length 95th (ft)	0	0	0
Control Delay (s)	9.6	0.0	0.2
Lane LOS	A		A
Approach Delay (s)	9.6	0.0	0.2
Approach LOS	A		

Intersection Summary			
Average Delay	0.2		
Intersection Capacity Utilization	29.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing
24: Sunflower Road & US 56 — PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	2	6	28	1	0	7	138	31	0	279	1
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	0	2	6	30	1	0	7	147	33	0	297	1
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	476	492	297	483	476	163	298			180		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	476	492	297	483	476	163	298			180		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	99	94	100	100	99			100		
cM capacity (veh/h)	499	478	742	486	488	887	1269			1408		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	9	31	187	298
Volume Left	0	30	7	0
Volume Right	6	0	33	1
cSH	652	486	1269	1700
Volume to Capacity	0.01	0.06	0.01	0.18
Queue Length 95th (ft)	1	5	0	0
Control Delay (s)	10.6	12.9	0.4	0.0
Lane LOS	B	B	A	
Approach Delay (s)	10.6	12.9	0.4	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	29.9%	ICU Level of Service	A
Analysis Period (min)	15		

2008 Gardner Existing - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2008 Gardner Existing
25: US 56 & 4th Street — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	158	17	21	292	60	18
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	170	18	23	314	65	19
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			188		538	179
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			188		538	179
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		87	98
cM capacity (veh/h)			1386		496	864

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	188	337	84
Volume Left	0	23	65
Volume Right	18	0	19
cSH	1700	1386	550
Volume to Capacity	0.11	0.02	0.15
Queue Length 95th (ft)	0	1	13
Control Delay (s)	0.0	0.7	12.7
Lane LOS		A	B
Approach Delay (s)	0.0	0.7	12.7
Approach LOS			B

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	40.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing
26: 199th Street & Four Corners Road — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	2	32	41	2	7	1
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	2	34	44	2	7	1
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	46				83	45
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	46				83	45
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	100
cM capacity (veh/h)	1575				920	1031

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	36	46	9
Volume Left	2	0	7
Volume Right	0	2	1
cSH	1575	1700	933
Volume to Capacity	0.00	0.03	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.4	0.0	8.9
Lane LOS	A		A
Approach Delay (s)	0.4	0.0	8.9
Approach LOS			A

Intersection Summary			
Average Delay	1.0		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing
27: 199th Street & Gardner Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	17	16	11	27	32	10	79	10	32	160	40
Peak Hour Factor	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Hourly flow rate (vph)	25	21	20	14	34	40	12	99	12	40	200	50

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	66	88	124	290
Volume Left (vph)	25	14	13	40
Volume Right (vph)	20	40	13	50
Hadj (s)	-0.07	-0.21	0.02	-0.04
Departure Headway (s)	4.9	4.7	4.6	4.4
Degree Utilization, x	0.09	0.12	0.16	0.35
Capacity (veh/h)	663	688	736	786
Control Delay (s)	8.4	8.4	8.5	9.8
Approach Delay (s)	8.4	8.4	8.5	9.8
Approach LOS	A	A	A	A

Intersection Summary			
Delay	9.1		
HCM Level of Service	A		
Intersection Capacity Utilization	31.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Gardner Existing
30: US-56 & I-35 NB Loop — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	437	924	0	533	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	475	1004	0	579	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			1479		765	238
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1479		765	238
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			461		344	770

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	238	238	1004	290	290
Volume Left	0	0	0	0	0
Volume Right	0	0	1004	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.14	0.14	0.59	0.17	0.17
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	60.5%	ICU Level of Service	B
Analysis Period (min)	15		

2008 Gardner Existing - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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E-mail:

_________Operational Analysis_________

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/18/2008 10:15:14 AM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: Edgerton Road to Sunflower Road
Jurisdiction:
Analysis Year: 2008
Description: NEPA Traffic Study

_________Flow Inputs and Adjustments_________

Volume, V	1130	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	314	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	656	pc/h/ln

_________Speed Inputs and Adjustments_________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_________LOS and Performance Measures_________

Flow rate, vp	656	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	9.4	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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_________Operational Analysis_________

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/18/2008 10:15:14 AM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: Gardner Road to US 56
Jurisdiction: KDOT
Analysis Year: 2008
Description: NEPA Traffic Study

_________Flow Inputs and Adjustments_________

Volume, V	1830	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	508	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1062	pc/h/ln

_________Speed Inputs and Adjustments_________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_________LOS and Performance Measures_________

Flow rate, vp	1062	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	15.2	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2008 Gardner Existing - AM Peak Hour - HCS Freeway Mainline

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Operational Analysis

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/18/2008 10:15:14 AM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: Sunflower Road to Gardner Road
Jurisdiction: KDOT
Analysis Year: 2008
Description: NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	1360	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	378	v
Trucks and buses	8	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.962	
Driver population factor, fp	1.00	
Flow rate, vp	786	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	786	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	11.2	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/18/2008 10:15:14 AM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: US 56 to 151st Street
Jurisdiction: KDOT
Analysis Year: 2008
Description: NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	3060	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	850	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1751	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	1751	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	68.4	mi/h
Number of lanes, N	2	
Density, D	25.6	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

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_____Operational Analysis_____

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Analyst:                  Trishul Palekar
Agency or Company:        HDR Inc.
Date Performed:           3/18/2008 10:15:14 AM
Analysis Time Period:     AM
Freeway/Direction:        I-35 Southbound
From/To:                  151Street to US 56
Jurisdiction:             KDOT
Analysis Year:            2008
Description:  NEPA Traffic Study
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_____Flow Inputs and Adjustments_____

Volume, V	1400	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	389	v
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.948	
Driver population factor, fp	1.00	
Flow rate, vp	821	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	821	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	11.7	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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_____Operational Analysis_____

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Analyst:                  Trishul Palekar
Agency or Company:        HDR Inc.
Date Performed:           3/18/2008 10:15:14 AM
Analysis Time Period:     AM
Freeway/Direction:        I-35 Southbound
From/To:                  Gardner Road to Sunflower Road
Jurisdiction:             KDOT
Analysis Year:            2008
Description:  NEPA Traffic Study
```

_____Flow Inputs and Adjustments_____

Volume, V	500	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	139	v
Trucks and buses	18	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.917	
Driver population factor, fp	1.00	
Flow rate, vp	303	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	303	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	4.3	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

2008 Gardner Existing - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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E-mail:

Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/18/2008 10:15:14 AM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	Sunflower Road to Edgerton Road
Jurisdiction:	
Analysis Year:	2008
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	470	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	131	v
Trucks and buses	18	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.917	
Driver population factor, fp	1.00	
Flow rate, vp	285	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	285	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	4.1	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/18/2008 10:15:14 AM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	US 56 to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2008
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	540	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	150	v
Trucks and buses	21	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.905	
Driver population factor, fp	1.00	
Flow rate, vp	332	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	332	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	4.7	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

2008 Gardner Existing - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/18/2008 10:15:14 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Edgerton Road to Sunflower Road
Jurisdiction:	
Analysis Year:	2008
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	650	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	181	v
Trucks and buses	20	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.909	
Driver population factor, fp	1.00	
Flow rate, vp	397	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	397	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	5.7	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/18/2008 10:15:14 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Gardner Road to US 56
Jurisdiction:	KDOT
Analysis Year:	2008
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	920	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	256	v
Trucks and buses	16	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.926	
Driver population factor, fp	1.00	
Flow rate, vp	552	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	552	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	7.9	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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_________Operational Analysis_________

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/18/2008 10:15:14 AM
Analysis Time Period: PM
Freeway/Direction: I-35 Northbound
From/To: Sunflower Road to Gardner Road
Jurisdiction: KDOT
Analysis Year: 2008
Description: NEPA Traffic Study

_________Flow Inputs and Adjustments_________

Volume, V	730	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	203	v
Trucks and buses	18	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.917	
Driver population factor, fp	1.00	
Flow rate, vp	442	pc/h/ln

_________Speed Inputs and Adjustments_________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_________LOS and Performance Measures_________

Flow rate, vp	442	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	6.3	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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_________Operational Analysis_________

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/18/2008 10:15:14 AM
Analysis Time Period: PM
Freeway/Direction: I-35 Northbound
From/To: US 56 to 151st Street
Jurisdiction: KDOT
Analysis Year: 2008
Description: NEPA Traffic Study

_________Flow Inputs and Adjustments_________

Volume, V	1750	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	486	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1016	pc/h/ln

_________Speed Inputs and Adjustments_________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_________LOS and Performance Measures_________

Flow rate, vp	1016	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	14.5	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2008 Gardner Existing - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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E-mail:

__________Operational Analysis__________

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/18/2008 10:15:14 AM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: 151Street to US 56
Jurisdiction: KDOT
Analysis Year: 2008
Description: NEPA Traffic Study

__________Flow Inputs and Adjustments__________

Volume, V	2910	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	808	v
Trucks and buses	7	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.966	
Driver population factor, fp	1.00	
Flow rate, vp	1673	pc/h/ln

__________Speed Inputs and Adjustments__________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

__________LOS and Performance Measures__________

Flow rate, vp	1673	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	69.0	mi/h
Number of lanes, N	2	
Density, D	24.2	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

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__________Operational Analysis__________

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/18/2008 10:15:14 AM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: Gardner Road to Sunflower Road
Jurisdiction: KDOT
Analysis Year: 2008
Description: NEPA Traffic Study

__________Flow Inputs and Adjustments__________

Volume, V	1530	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	425	v
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.948	
Driver population factor, fp	1.00	
Flow rate, vp	897	pc/h/ln

__________Speed Inputs and Adjustments__________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

__________LOS and Performance Measures__________

Flow rate, vp	897	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	12.8	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

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___Operational Analysis___

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/18/2008 10:15:14 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	Sunflower Road to Edgerton Road
Jurisdiction:	
Analysis Year:	2008
Description:	NEPA Traffic Study

___Flow Inputs and Adjustments___

Volume, V	1320	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	367	v
Trucks and buses	12	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.943	
Driver population factor, fp	1.00	
Flow rate, vp	777	pc/h/ln

___Speed Inputs and Adjustments___

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

___LOS and Performance Measures___

Flow rate, vp	777	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	11.1	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

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E-mail:

___Operational Analysis___

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/18/2008 10:15:14 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	US 56 to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2008
Description:	NEPA Traffic Study

___Flow Inputs and Adjustments___

Volume, V	1950	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	542	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1132	pc/h/ln

___Speed Inputs and Adjustments___

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

___LOS and Performance Measures___

Flow rate, vp	1132	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	16.2	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2008 Gardner Existing - AM Peak Hour - HCS Freeway Ramps

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                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 11:10:33 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1130          vph

________________________________Off Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              11            vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1130        11                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                314         3                    v
Trucks and buses                       9           9                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
    Grade                              0.00    %   0.00    %            %
    Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.957       0.881
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1312        14                      pcph

________________________Estimation of V12 Diverge Areas_______________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1312   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v  = v                1312          4800            No
      Fi   F
     v  = v - v            1298          4800            No
      FO   F   R
     v                     14            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1312          4600                   No
      12                                                                     !
_________________Level of Service Determination (if not F)___________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   8.3     pc/mi/ln
                                          R            12        D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                 D  = 0.429
                                              S
Space mean speed in ramp influence area,     S  = 58.0    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 58.0    mph
______________________________________________________________________________
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                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 11:10:33 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1119          vph

_________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              238           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1119        238                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                311         66                   v
Trucks and buses                       9           2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
    Grade                                      %           %            %
    Length                                     mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.957       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1299        272                     pcph

________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1299   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v                     1571          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1299          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   12.6    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                 M  = 0.284
                                              S
Space mean speed in ramp influence area,     S  = 62.1    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.1    mph
______________________________________________________________________________
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2008 Gardner Existing - AM Peak Hour - HCS Freeway Ramps

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                  HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                      Fax:
E-mail:

_________________________________Diverge Analysis_______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1360           vph

_________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              86             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1360        86                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                378         24                   v
Trucks and buses                       8           2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
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Heavy vehicle adjustment, fHV          0.962       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1572        98                   pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1572   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                            Actual        Maximum         LOS F?
     v  = v                 1572          4800            No
      Fi   F
     v  = v - v             1474          4800            No
      FO   F   R
     v                      98            2000            No
      R
     v     v                0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?           No
      3 or  av34
Is   v     v       > 1.5 v  /2            No
      3 or  av34        12
If yes, v    =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area______________________
                       Actual        Max Desirable         Violation?
     v                 1572          4600                  No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   10.6    pc/mi/ln
                      R                  12         D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation____________________________________

Intermediate speed variable,                 D  = 0.437
                                              S
Space mean speed in ramp influence area,     S  = 57.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.8    mph
________________________________________________________________________________
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                  HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                      Fax:
E-mail:

_________________________________Merge Analysis_________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1274           vph

__________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              554            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1274        554                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                354         154                  v
Trucks and buses                       8           2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.962       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1472        634                  pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1472   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                            Actual        Maximum         LOS F?
     v                      2106          4800            No
      FO
     v     v                0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?           No
      3 or  av34
Is   v     v       > 1.5 v  /2            No
      3 or  av34        12
If yes, v    =                            (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                       Actual        Max Desirable         Violation?
     v                 1472          4400                  No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   16.6    pc/mi/ln
          R                  R            12            A
Level of service for ramp-freeway junction areas of influence  B

____________________________Speed Estimation____________________________________

Intermediate speed variable,                 M  = 0.297
                                              S
Space mean speed in ramp influence area,     S  = 61.7    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.7    mph
________________________________________________________________________________
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2008 Gardner Existing - AM Peak Hour - HCS Freeway Ramps

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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1830           vph

_________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              227            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1830        227                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                508         63                    v
Trucks and buses                       6           7                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %             %
     Length                            0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.971       0.905
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2094        279                   pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2094   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                2094          4800            No
      Fi   F
     v  = v - v            1815          4800            No
      FO   F   R
     v                     279           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v   =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2094          4600                   No
      12                                                                      !
________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   15.1    pc/mi/ln
                                          R             12         D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation___________________________________

Intermediate speed variable,                 D  = 0.453
                                              S
Space mean speed in ramp influence area,     S  = 57.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.3    mph
_______________________________________________________________________________
```

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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 11:10:33 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           2946           vph

__________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              118            vph
Length of first accel/decel lane            1000           ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        2946        118                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                818         33                    v
Trucks and buses                       6           2                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                                     %           %             %
     Length                                    mi          mi            mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.971       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3372        135                   pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  3372   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     3507          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v   =                            (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                3372          4400                   No
      12                                                                      !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   26.5    pc/mi/ln
                              R            12            A
Level of service for ramp-freeway junction areas of influence  C

____________________________Speed Estimation___________________________________

Intermediate speed variable,                 M  = 0.381
                                              S
Space mean speed in ramp influence area,     S  = 59.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 59.3    mph
_______________________________________________________________________________
```

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                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis_________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1603          vph

__________________________________On Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            1343          vph
Length of first accel/decel lane          500           ft
Length of second accel/decel lane                       ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1603        1343                 vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               445         373                  v
Trucks and buses                      6           2                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                                    %           %            %
     Length                                   mi          mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.971       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1835        1537                    pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1835   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     3372          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v         > 2700 pc/h?        No
      3 or  av34
Is   v     v         > 1.5 v  /2         No
      3 or  av34            12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                1835          4400                  No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   27.9    pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  C

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.400
                                              S
Space mean speed in ramp influence area,     S  = 58.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 58.8    mph
________________________________________________________________________________
```

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Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis_______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               8 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1400          vph

_________________________________Off Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   45.0          mph
Volume on ramp                            924           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1400        924                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               389         257                  v
Trucks and buses                      9           3                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %            %
     Length                           0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.957       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1626        1073                    pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1626   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1626          4800            No
      Fi   F
     v  = v - v            553           4800            No
      FO   F   R
     v                     1073          2100            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v         > 2700 pc/h?        No
      3 or  av34
Is   v     v         > 1.5 v  /2         No
      3 or  av34            12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                1626          4600                  No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   11.0    pc/mi/ln
                                           R            12          D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.395
                                              S
Space mean speed in ramp influence area,     S  = 59.0    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 59.0    mph
________________________________________________________________________________
```

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Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               9 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         476           vph

__________________________________On Ramp Data_______________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            63            vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

_________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       476         63                    vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               132         18                    v
Trucks and buses                      9           16                    %
Recreational vehicles                 0           0                     %
Terrain type:                         Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.957       0.806
Driver population factor, fP          1.00        1.00
Flow rate, vp                         553         87                    pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  553    pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v                     640           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                553           4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   5.4     pc/mi/ln
         R                    R           12            A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                M  = 0.272
                                             S
Space mean speed in ramp influence area,    S  = 62.4    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 62.4    mph
______________________________________________________________________________
```

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                      HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis____________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         540           vph

_________________________________Off Ramp Data_______________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            94            vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

_________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       540         94                    vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               150         26                    v
Trucks and buses                      19          13                    %
Recreational vehicles                 0           0                     %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %           %
     Length                           0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.913       0.837
Driver population factor, fP          1.00        1.00
Flow rate, vp                         657         125                   pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  657    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v  = v                657           4800            No
      Fi   F
     v  = v - v            532           4800            No
      FO   F   R
     v                     125           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                657           4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   2.7     pc/mi/ln
                        R                  12         D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                D  = 0.439
                                             S
Space mean speed in ramp influence area,    S  = 57.7    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.7    mph
______________________________________________________________________________
```

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                  HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 11:10:33 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          445            vph

__________________________________On Ramp Data_______________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             50             vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                        445         50                    vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                124         14                    v
Trucks and buses                       19          4                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.913       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          541         59                      pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  541    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     600           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                541           4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   5.1     pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  A

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.272
                                              S
Space mean speed in ramp influence area,     S  = 62.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.4    mph
________________________________________________________________________________
```

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Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 11:10:33 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          500            vph

_________________________________Off Ramp Data_______________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0           mph
Volume on ramp                             35             vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                        500         35                    vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                139         10                    v
Trucks and buses                       18          6                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %             %
     Length                            0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.917       0.917
Driver population factor, fP           1.00        1.00
Flow rate, vp                          606         42                      pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  606    pc/h
                   12   R      F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                606           4800            No
      Fi   F
     v  = v - v            564           4800            No
      FO   F   R
     v                     42            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                606           4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,                D = 4.252 + 0.0086 v  - 0.009  L   =   2.3     pc/mi/ln
                                           R            12           D
Level of service for ramp-freeway junction areas of influence A

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.432
                                              S
Space mean speed in ramp influence area,     S  = 57.9    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.9    mph
________________________________________________________________________________
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2008 Gardner Existing - AM Peak Hour - HCS Freeway Ramps

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                 HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                         Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           465            vph

__________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              4              vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        465         4                     vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                129         1                     v
Trucks and buses                       18          0                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                                     %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.917       1.000
Driver population factor, fP           1.00        1.00
Flow rate, vp                          563         4                     pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  563    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     567           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                563           4400                  No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   4.9     pc/mi/ln
          R                   R          12            A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.272
                                              S
Space mean speed in ramp influence area,     S  = 62.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.4    mph
_______________________________________________________________________________
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Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 11:10:33 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         650           vph

_________________________________Off Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            5             vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        650         5                    vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                181                              v
Trucks and buses                       20          0                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.909       1.000
Driver population factor, fP           1.00        1.00
Flow rate, vp                          794         6                    pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  794    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                           Actual        Maximum        LOS F?
     v  = v                794           4800           No
      Fi   F
     v  = v - v            788           4800           No
      FO   F   R
     v                     6             2000           No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable          Violation?
     v                794           4600                   No
      12                                                                  !
_________________Level of Service Determination (if not F)___________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   3.9     pc/mi/ln
                          R                 12        D
Level of service for ramp-freeway junction areas of influence A

______________________________Speed Estimation________________________________

Intermediate speed variable,                 D  = 0.429
                                              S
Space mean speed in ramp influence area,     S  = 58.0    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 58.0    mph
______________________________________________________________________________
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Phone:                                   Fax:
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_________________________________Merge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 11:10:33 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         645           vph

__________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            87            vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        645         87                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                179         24                   v
Trucks and buses                       20          5                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.909       0.930
Driver population factor, fP           1.00        1.00
Flow rate, vp                          788         104                  pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  788    pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum        LOS F?
     v                     892           4800           No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area___________________
                      Actual        Max Desirable          Violation?
     v                788           4400                   No
      12                                                                  !
_________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   7.4     pc/mi/ln
             R                R          12           A
Level of service for ramp-freeway junction areas of influence  A

______________________________Speed Estimation________________________________

Intermediate speed variable,                 M  = 0.275
                                              S
Space mean speed in ramp influence area,     S  = 62.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.3    mph
______________________________________________________________________________
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Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         730            vph

_________________________________Off Ramp Data___________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0           mph
Volume on ramp                            55             vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

_________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                  Freeway     Ramp        Adjacent
                                                             Ramp
Volume, V (vph)                      730         55                   vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              203         15                   v
Trucks and buses                     18          7                    %
Recreational vehicles                0           0                    %
Terrain type:                        Level       Rolling
     Grade                           0.00    %   0.00    %            %
     Length                          0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
Heavy vehicle adjustment, fHV        0.917       0.905
Driver population factor, fP         1.00        1.00
Flow rate, vp                        884         68                   pcph

_________________________Estimation of V12 Diverge Areas_________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  884    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v  = v                884           4800            No
      Fi   F
     v  = v - v            816           4800            No
      FO   F   R
     v                     68            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual        Max Desirable         Violation?
     v                884           4600                  No
      12                                                                         !
_________________Level of Service Determination (if not F)______________________

Density,           D = 4.252 + 0.0086 v  - 0.009  L   =   4.7     pc/mi/ln
                                       R              12       D
Level of service for ramp-freeway junction areas of influence A

______________________________Speed Estimation___________________________________

Intermediate speed variable,                  D  = 0.434
                                               S
Space mean speed in ramp influence area,      S  = 57.8    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 57.8    mph
_________________________________________________________________________________
```

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Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         675            vph

__________________________________On Ramp Data___________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0           mph
Volume on ramp                            239            vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

_________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                  Freeway     Ramp        Adjacent
                                                             Ramp
Volume, V (vph)                      675         239                  vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              188         66                   v
Trucks and buses                     18          6                    %
Recreational vehicles                0           0                    %
Terrain type:                        Level       Rolling
     Grade                                   %           %            %
     Length                                  mi          mi           mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
Heavy vehicle adjustment, fHV        0.917       0.917
Driver population factor, fP         1.00        1.00
Flow rate, vp                        818         289                  pcph

_________________________Estimation of V12 Merge Areas___________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  818    pc/h
                   12   F   FM

_______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v                     1107          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable         Violation?
     v                818           4400                  No
      12                                                                         !
_________________Level of Service Determination (if not F)______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   9.0     pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  A

______________________________Speed Estimation___________________________________

Intermediate speed variable,                  M  = 0.277
                                               S
Space mean speed in ramp influence area,      S  = 62.2    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 62.2    mph
_________________________________________________________________________________
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Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         920            vph

_________________________________Off Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0           mph
Volume on ramp                            107            vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                      Freeway     Ramp        Adjacent
                                                                 Ramp
Volume, V (vph)                          920         107                  vph
Peak-hour factor, PHF                    0.90        0.90
Peak 15-min volume, v15                  256         30                   v
Trucks and buses                         16          9                    %
Recreational vehicles                    0           0                    %
Terrain type:                            Level       Rolling
     Grade                               0.00    %   0.00    %            %
     Length                              0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                 1.5*        2.5
Recreational vehicle PCE, ER             1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.926       0.881
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1104        135                      pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1104   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1104          4800            No
      Fi   F
     v  = v - v            969           4800            No
      FO   F   R
     v                     135           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1104          4600                   No
      12                                                                       !
_________________Level of Service Determination (if not F)____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   6.5     pc/mi/ln
                                         R            12      D
Level of service for ramp-freeway junction areas of influence A

____________________________Speed Estimation___________________________________

Intermediate speed variable,                 D  = 0.440
                                              S
Space mean speed in ramp influence area,     S  = 57.7    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.7    mph
________________________________________________________________________________
```

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         1732           vph

__________________________________On Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0           mph
Volume on ramp                            18             vph
Length of first accel/decel lane          1000           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                      Freeway     Ramp        Adjacent
                                                                 Ramp
Volume, V (vph)                          1732        18                   vph
Peak-hour factor, PHF                    0.90        0.90
Peak 15-min volume, v15                  481         5                    v
Trucks and buses                         16          3                    %
Recreational vehicles                    0           0                    %
Terrain type:                            Level       Rolling
     Grade                                       %           %            %
     Length                                      mi          mi           mi
Trucks and buses PCE, ET                 1.5*        2.5
Recreational vehicle PCE, ER             1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.926       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2078        21                       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2078   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2099          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2078          4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   15.6    pc/mi/ln
                              R            12           A
Level of service for ramp-freeway junction areas of influence  B

____________________________Speed Estimation___________________________________

Intermediate speed variable,                 M  = 0.283
                                              S
Space mean speed in ramp influence area,     S  = 62.1    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.1    mph
________________________________________________________________________________
```

```
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Phone:                                     Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           813            vph

__________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              924            vph
Length of first accel/decel lane            500            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         813         924                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 226         257                   v
Trucks and buses                        16          3                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                                  %           %           %
     Length                                 mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.926       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           976         1073                  pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  976    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2049          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v     =                          (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                976           4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   17.8    pc/mi/ln
          R                   R            12           A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.316
                                              S
Space mean speed in ramp influence area,     S  = 61.1    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.1    mph
_______________________________________________________________________________
```

```
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Phone:                                     Fax:
E-mail:

_________________________________Diverge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               8 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           2910           vph

_________________________________Off Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     45.0           mph
Volume on ramp                              1250           vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2910        1250                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 808         347                   v
Trucks and buses                        7           2                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %           %
     Length                             0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.966       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3346        1431                  pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  3346   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                3346          4800            No
      Fi   F
     v  = v - v            1915          4800            No
      FO   F   R
     v                     1431          2100            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v     =                          (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                3346          4600                   No
      12                                                                     !
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   25.8    pc/mi/ln
                                          R           12          D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.427
                                              S
Space mean speed in ramp influence area,     S  = 58.0    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 58.0    mph
_______________________________________________________________________________
```

2008 Gardner Existing - PM Peak Hour - HCS Freeway Ramps

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Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          3/18/2008 11:13:41 AM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Southbound
Junction:                9 US 56 Entr
Jurisdiction:            KDOT
Analysis Year:           2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                         Merge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0          mph
Volume on freeway                        1660          vph

__________________________________On Ramp Data_________________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-flow speed on ramp                  35.0          mph
Volume on ramp                           292           vph
Length of first accel/decel lane         800           ft
Length of second accel/decel lane                      ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                No
Volume on adjacent Ramp                                vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                              ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                  Freeway     Ramp        Adjacent
                                                             Ramp
Volume, V (vph)                      1660        292                   vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              461         81                    v
Trucks and buses                     7           3                     %
Recreational vehicles                0           0                     %
Terrain type:                        Level       Rolling
     Grade                                  %           %           %
     Length                                 mi          mi          mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
```

```
Heavy vehicle adjustment, fHV            0.966       0.957
Driver population factor, fP             1.00        1.00
Flow rate, vp                            1909        339                   pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1909   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2248          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                1909          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   17.8    pc/mi/ln
          R                  R            12            A
Level of service for ramp-freeway junction areas of influence  B

_______________________________Speed Estimation_________________________________

Intermediate speed variable,                 M  = 0.302
                                              S
Space mean speed in ramp influence area,     S  = 61.5    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.5    mph
_______________________________________________________________________________
```

```
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Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis______________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          3/18/2008 11:13:41 AM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Southbound
Junction:                10 Gardner Exit
Jurisdiction:            KDOT
Analysis Year:           2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                         Diverge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0          mph
Volume on freeway                        1950          vph

_________________________________Off Ramp Data_________________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-Flow speed on ramp                  35.0          mph
Volume on ramp                           508           vph
Length of first accel/decel lane         800           ft
Length of second accel/decel lane                      ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                No
Volume on adjacent ramp                                vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                              ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                  Freeway     Ramp        Adjacent
                                                             Ramp
Volume, V (vph)                      1950        508                   vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              542         141                   v
Trucks and buses                     9           5                     %
Recreational vehicles                0           0                     %
Terrain type:                        Level       Rolling
     Grade                           0.00   %    0.00   %           %
     Length                          0.00   mi   0.00   mi          mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
```

```
Heavy vehicle adjustment, fHV            0.957       0.930
Driver population factor, fP             1.00        1.00
Flow rate, vp                            2264        607                   pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2264   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                2264          4800            No
      Fi   F
     v  = v - v            1657          4800            No
      FO   F   R
     v                     607           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2264          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   16.5    pc/mi/ln
                                         R            12          D
Level of service for ramp-freeway junction areas of influence B

_______________________________Speed Estimation_________________________________

Intermediate speed variable,                 D  = 0.483
                                              S
Space mean speed in ramp influence area,     S  = 56.5    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 56.5    mph
_______________________________________________________________________________
```

2008 Gardner Existing - PM Peak Hour - HCS Freeway Ramps

```
                   HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                         Merge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0         mph
Volume on freeway                        1442         vph

__________________________________On Ramp Data_________________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-flow speed on ramp                  35.0         mph
Volume on ramp                           87           vph
Length of first accel/decel lane         800          ft
Length of second accel/decel lane                     ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                No
Volume on adjacent Ramp                               vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                             ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                  Freeway     Ramp        Adjacent
                                                             Ramp
Volume, V (vph)                      1442        87                   vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              401         24                   v
Trucks and buses                     9           6                    %
Recreational vehicles                0           0                    %
Terrain type:                        Level       Rolling
     Grade                                   %           %            %
     Length                                  mi          mi           mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
```

```
Heavy vehicle adjustment, fHV            0.957       0.917
Driver population factor, fP             1.00        1.00
Flow rate, vp                            1674        105                    pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1674   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1779          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v     =                          (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1674          4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   14.3    pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                M  = 0.288
                                             S
Space mean speed in ramp influence area,    S  = 61.9    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 61.9    mph
_______________________________________________________________________________
```

```
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Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 11:10:33 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                         Diverge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0         mph
Volume on freeway                        1530         vph

________________________________Off Ramp Data__________________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-Flow speed on ramp                  35.0         mph
Volume on ramp                           236          vph
Length of first accel/decel lane         800          ft
Length of second accel/decel lane                     ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                No
Volume on adjacent ramp                               vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                             ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                  Freeway     Ramp        Adjacent
                                                             Ramp
Volume, V (vph)                      1530        236                  vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              425         66                   v
Trucks and buses                     11          2                    %
Recreational vehicles                0           0                    %
Terrain type:                        Level       Rolling
     Grade                           0.00    %   0.00    %            %
     Length                          0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
```

```
Heavy vehicle adjustment, fHV            0.948       0.971
Driver population factor, fP             1.00        1.00
Flow rate, vp                            1794        270                    pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1794   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1794          4800            No
      Fi   F
     v  = v - v            1524          4800            No
      FO   F   R
     v                     270           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v     =                          (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1794          4600                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   12.5    pc/mi/ln
                                        R            12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                D  = 0.452
                                             S
Space mean speed in ramp influence area,    S  = 57.3    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.3    mph
_______________________________________________________________________________
```

2008 Gardner Existing - PM Peak Hour - HCS Freeway Ramps

```
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Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 11:10:33 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1294          vph

__________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              25            vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1294        25                    vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                359         7                     v
Trucks and buses                       11          8                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                                     %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.948       0.893
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1517        31                    pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1517   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1548          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v     > 2700 pc/h?            No
      3 or  av34
Is   v     v     > 1.5 v  /2             No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1517          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   12.5    pc/mi/ln
          R                  R          12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.283
                                              S
Space mean speed in ramp influence area,     S  = 62.1    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.1    mph
_______________________________________________________________________________
```

Appendix C:
Peak Hour Truck Percent Figures

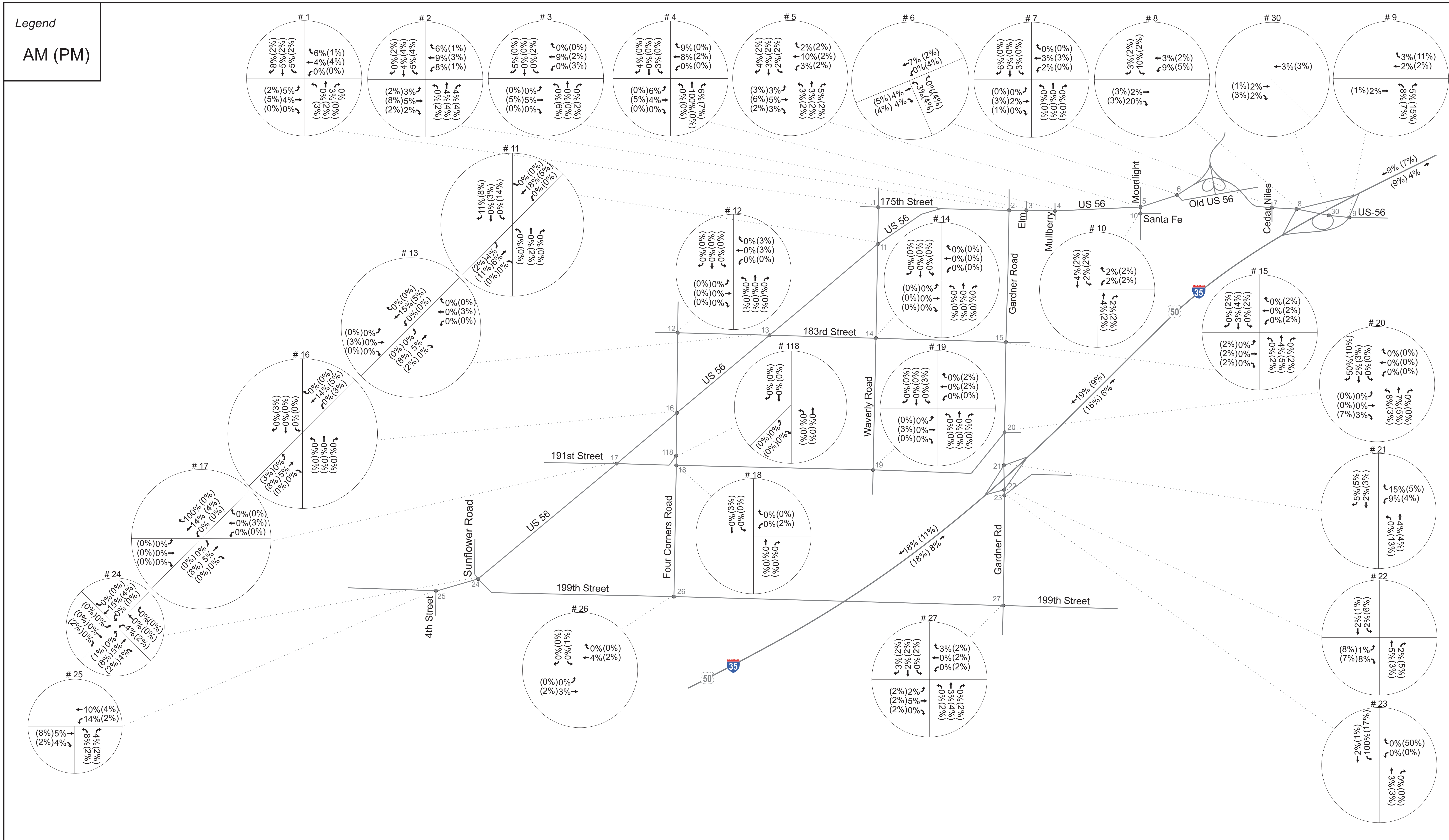

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Figure C-1: Existing (2008)
Peak Hour Truck Percentages

BNSF RAILWAY

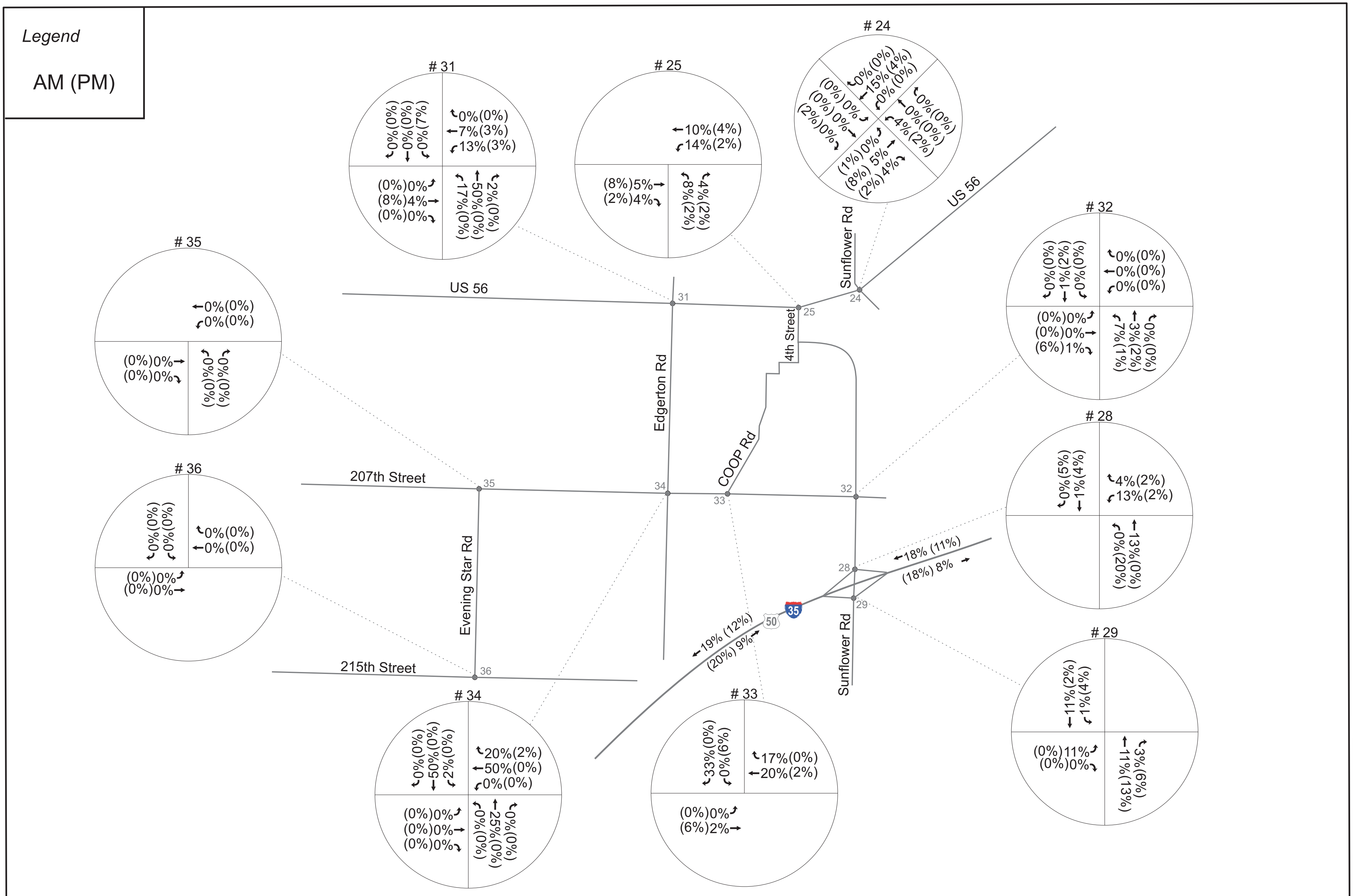

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Figure C-2: Existing (2008) Peak Hour Truck Percentages - Vicinity of Wellsville North Alternative

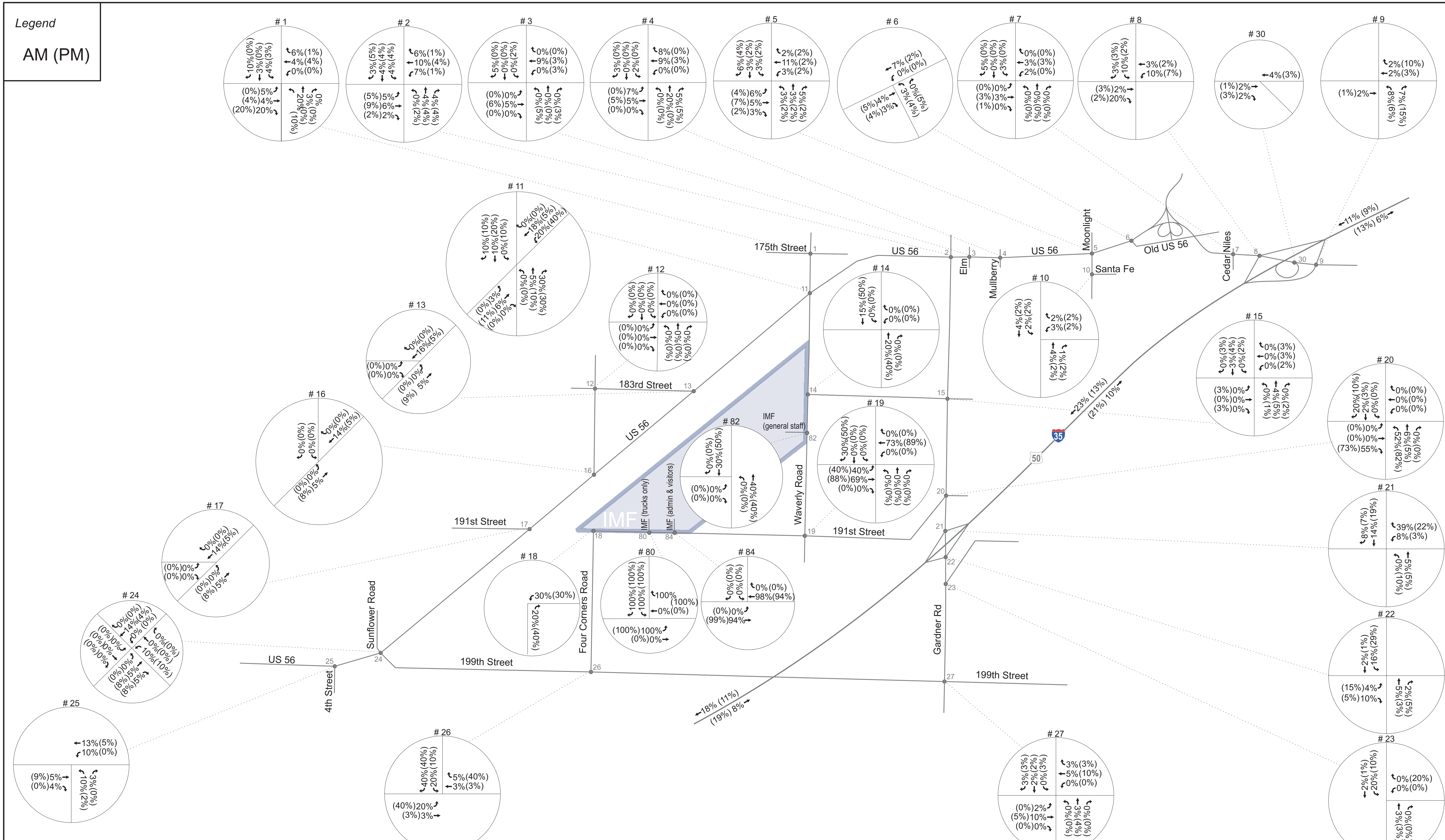

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Figure C-4: 2010 Gardner Proposed Action Peak Hour Truck Percentages

BNSF RAILWAY

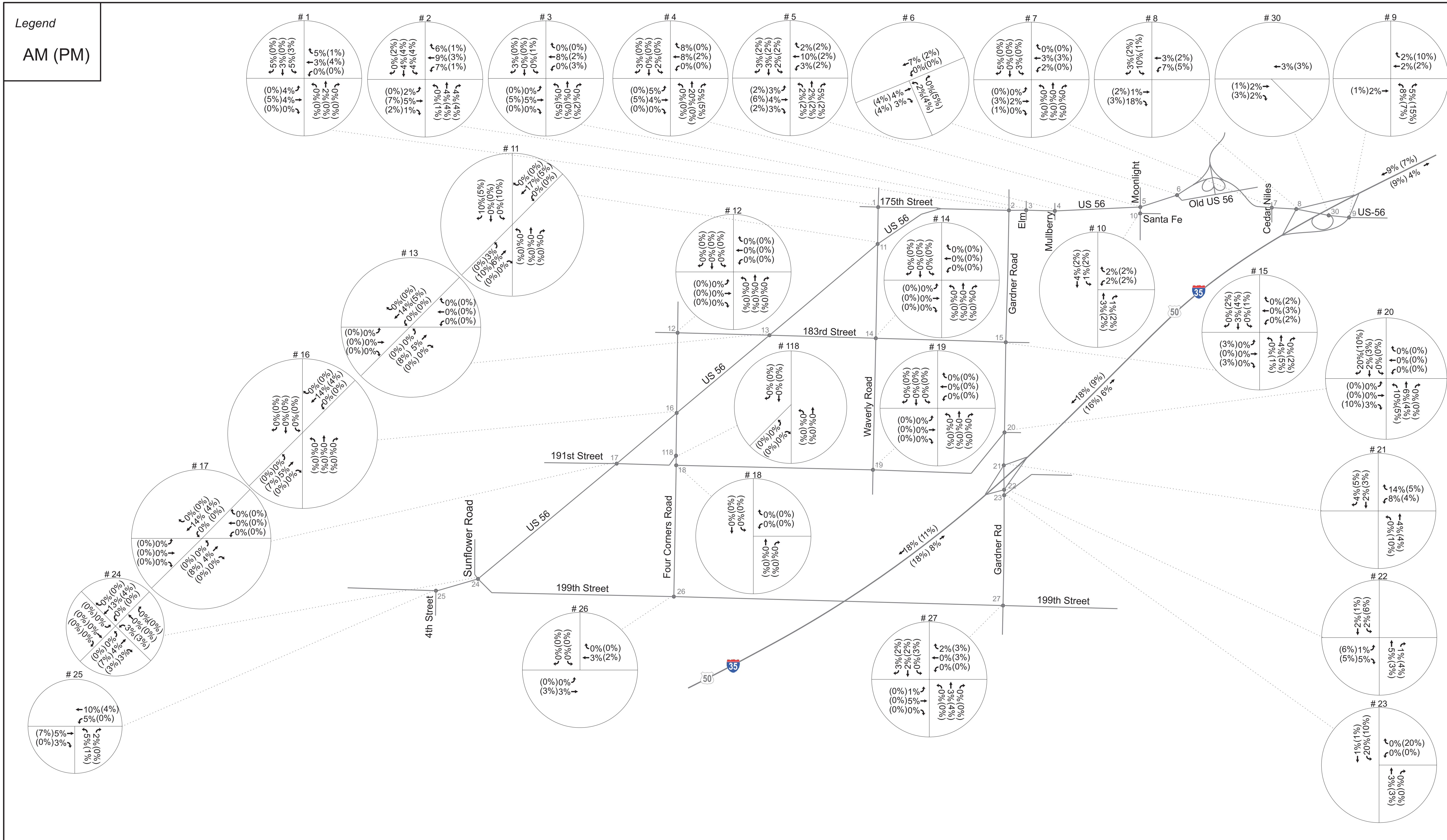

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Figure C-5: 2015 Gardner No-Action
Peak Hour Truck Percentages

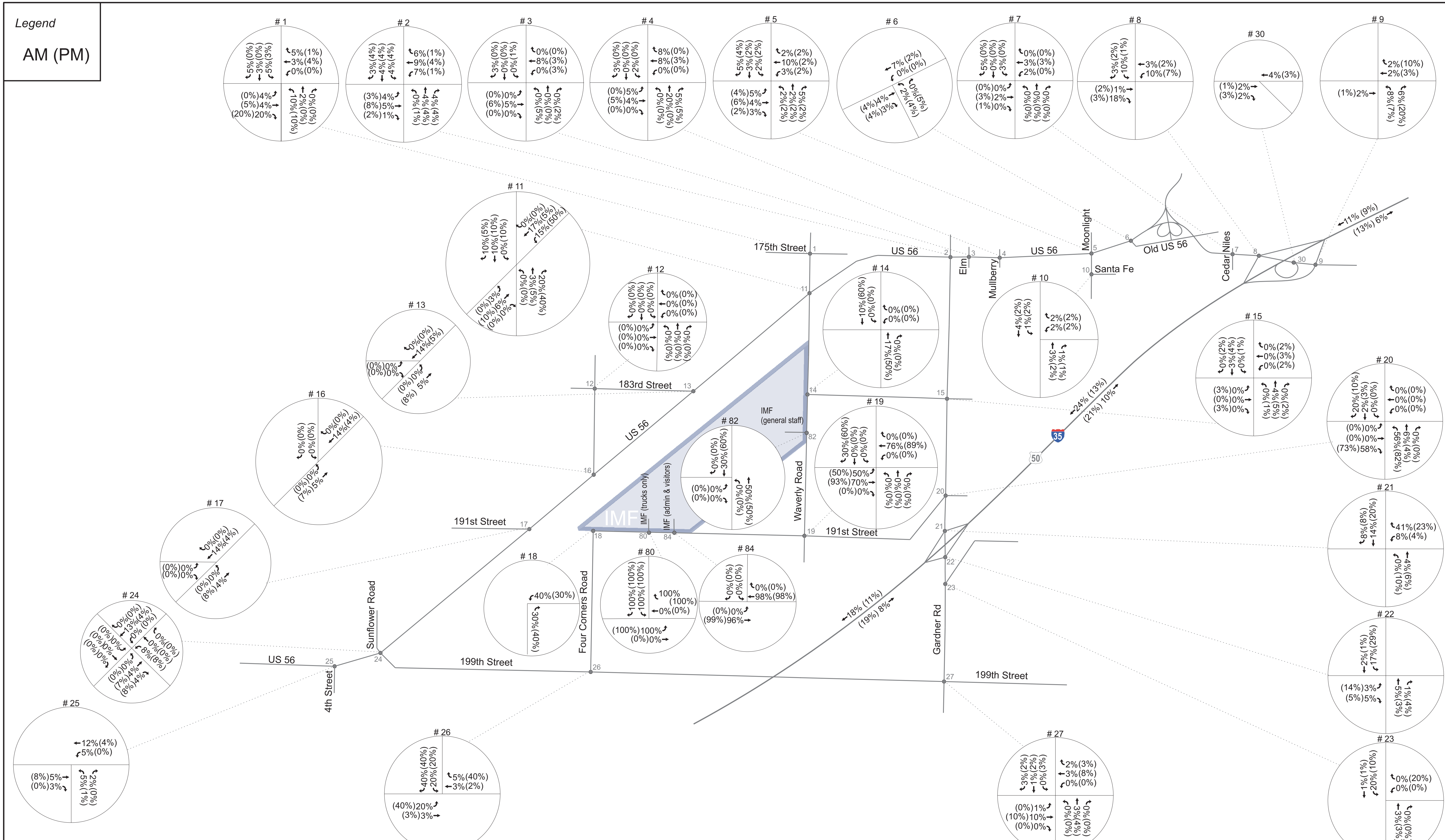

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Figure C-6: 2015 Gardner IMF Operations
Peak Hour Truck Percentages

BNSF RAILWAY

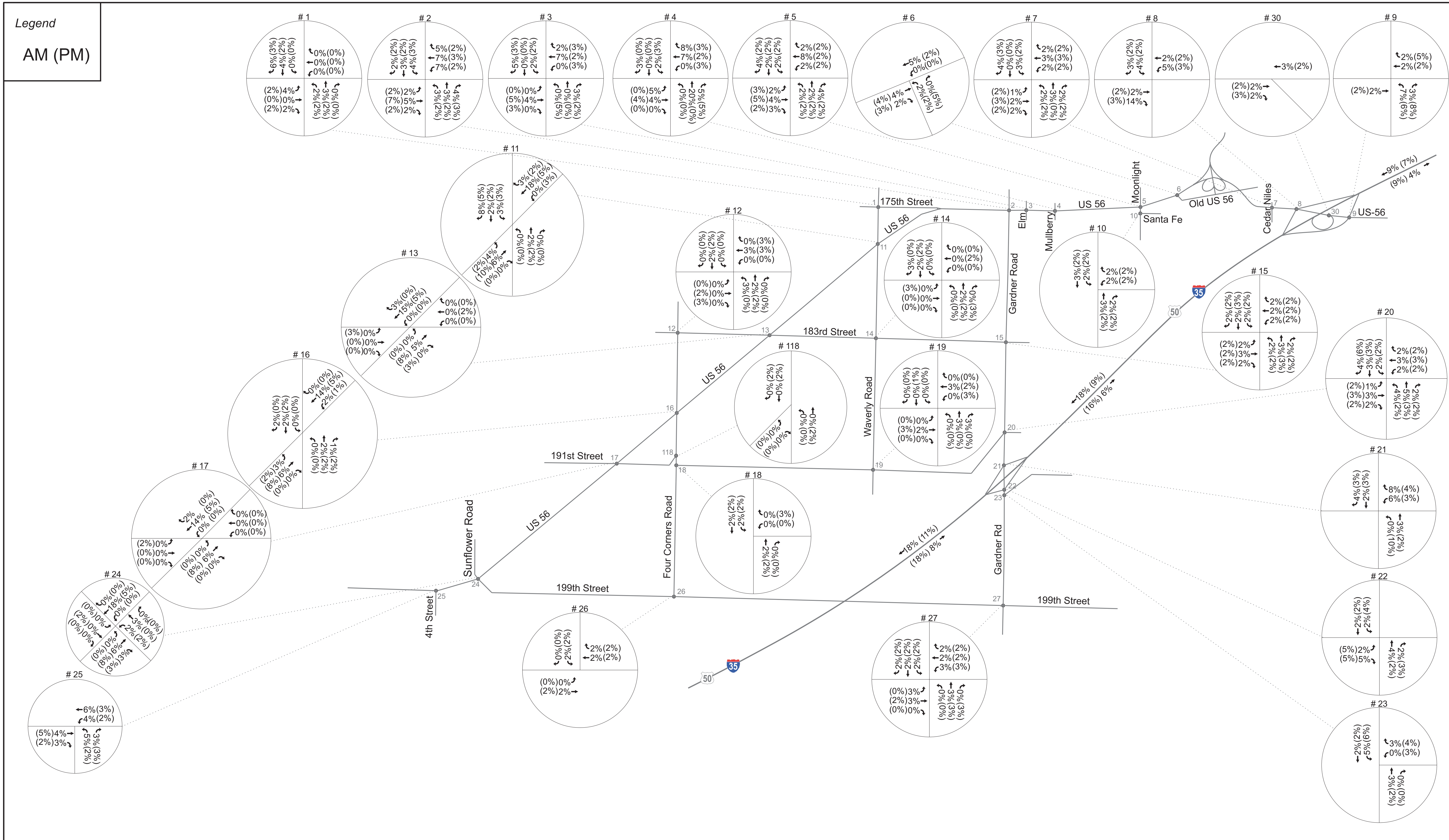

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Figure C-7: 2030 Gardner No Action
Peak Hour Truck Percentages

BNSF RAILWAY

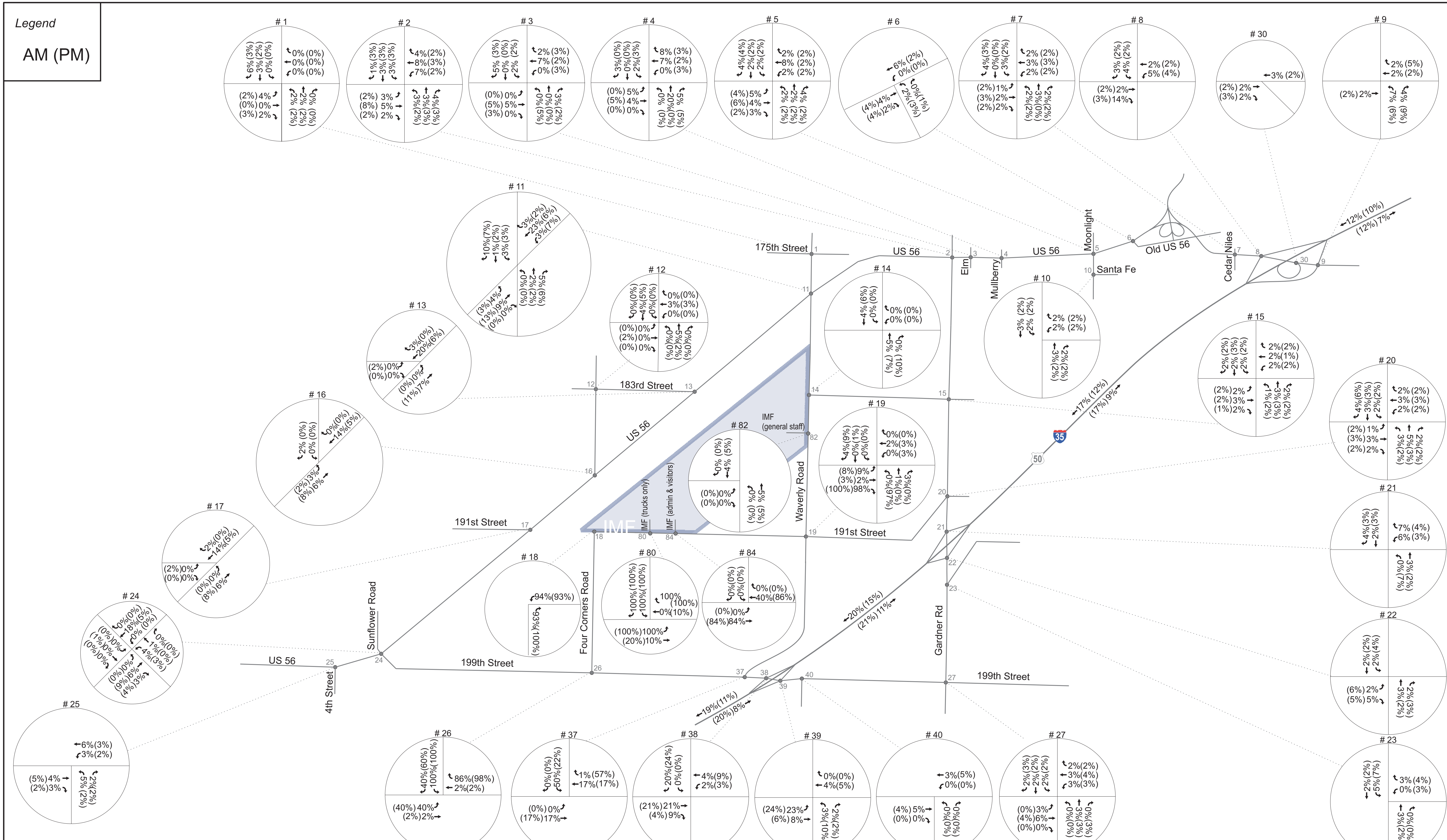

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Figure C-8: 2030 Gardner IMF Operations
Peak Hour Truck Percentages

BNSF RAILWAY

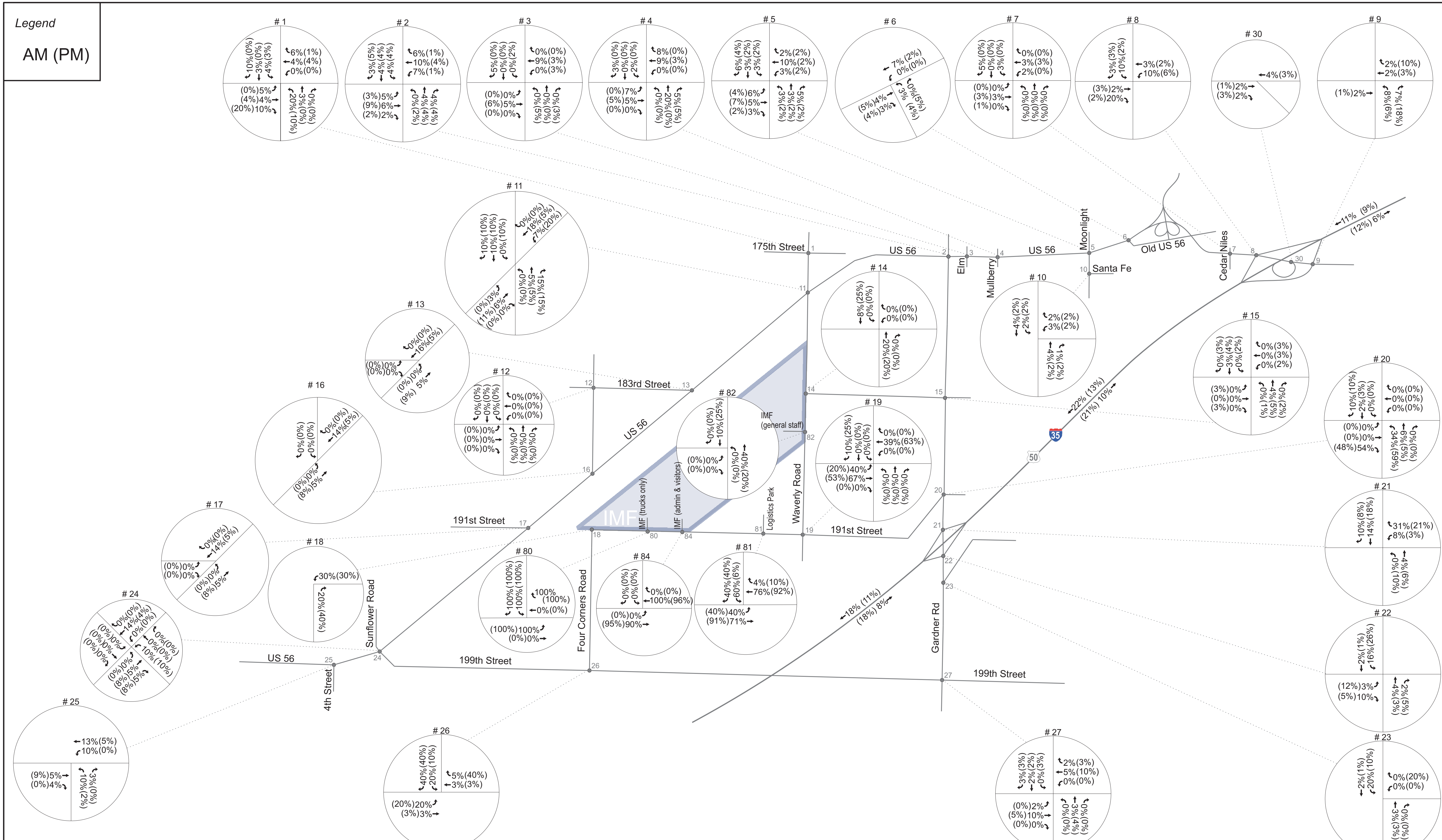

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Figure C-9: 2010 Gardner IMF Operations + Induced Development Peak Hour Truck Percentages

BNSF RAILWAY

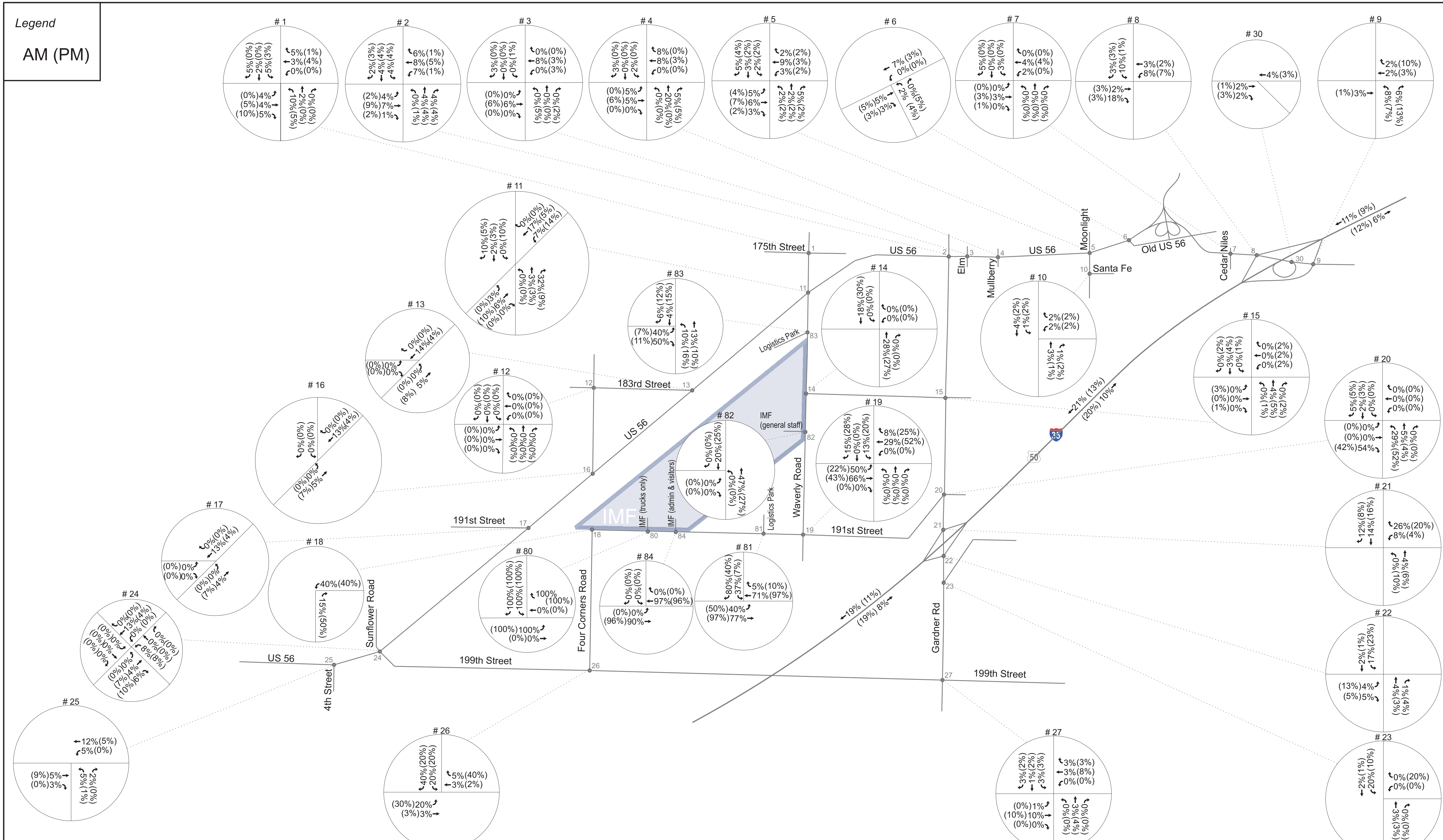

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Figure C-10: 2015 Gardner IMF Operations + Induced Development
Peak Hour Truck Percentages

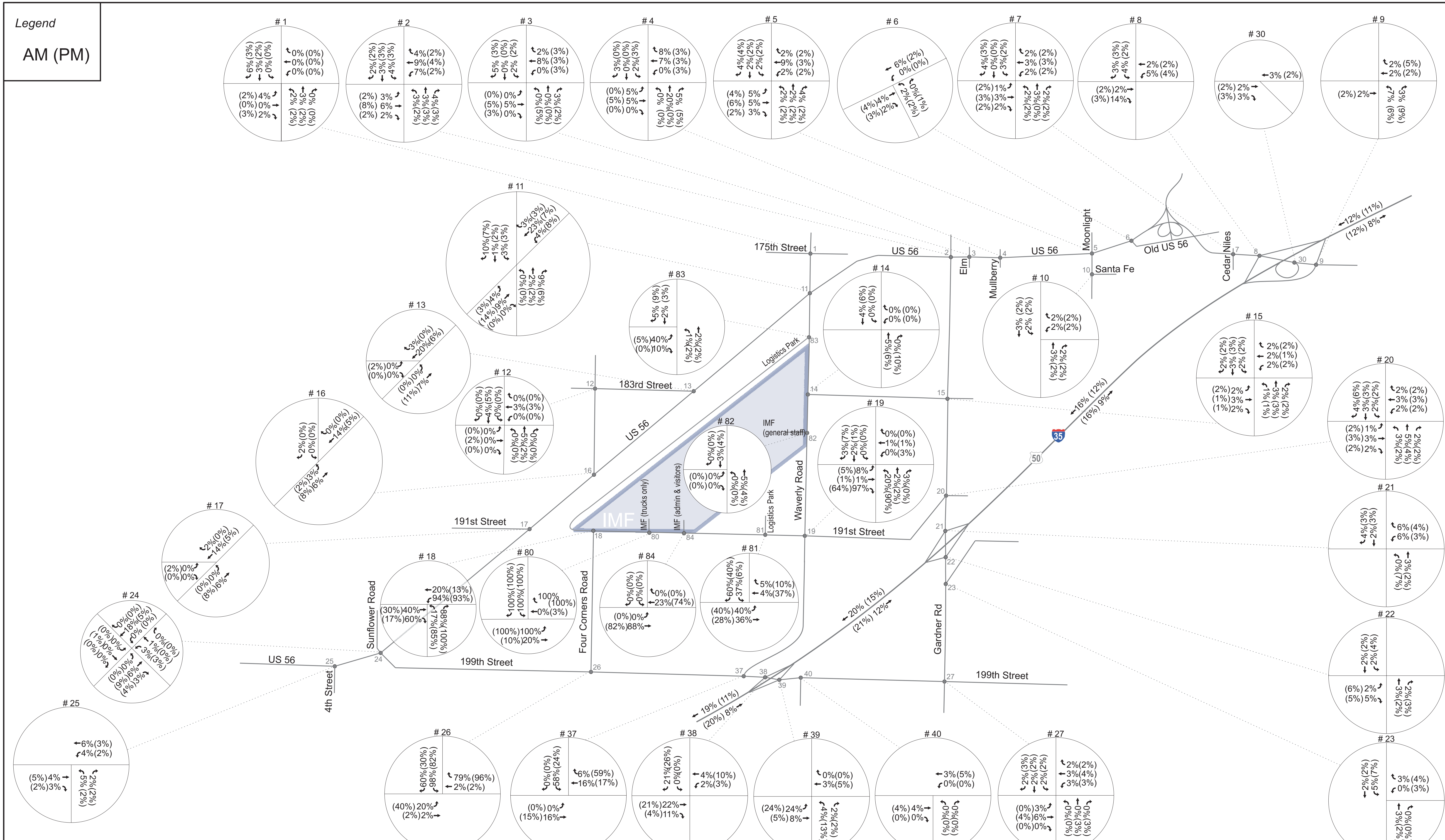

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Figure C-11: 2030 Gardner IMF Operations + Induced Development
Peak Hour Truck Percentages

BNSF RAILWAY

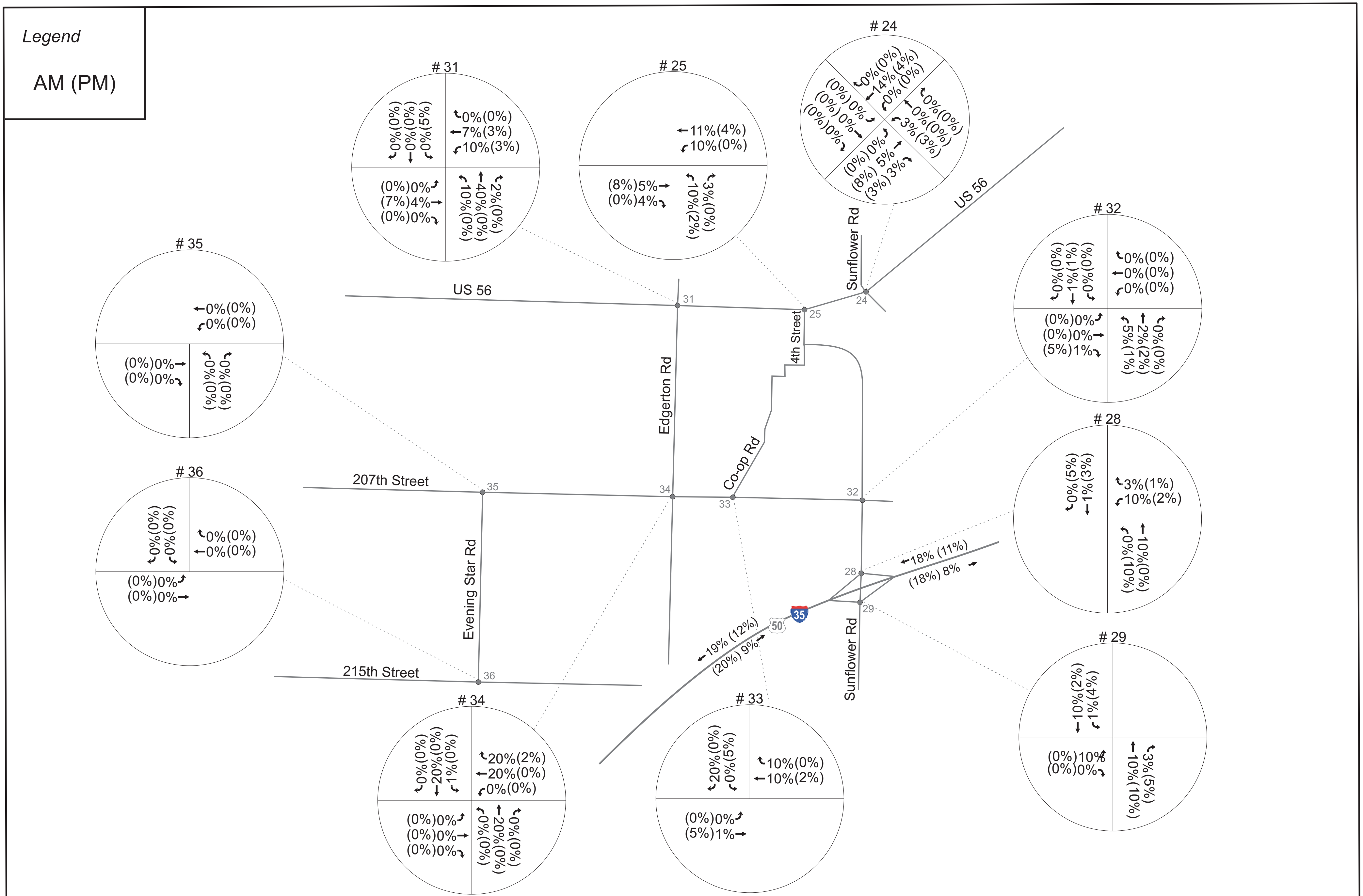

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Figure C-12: 2010 Wellsville North No Action
Peak Hour Truck Percentages

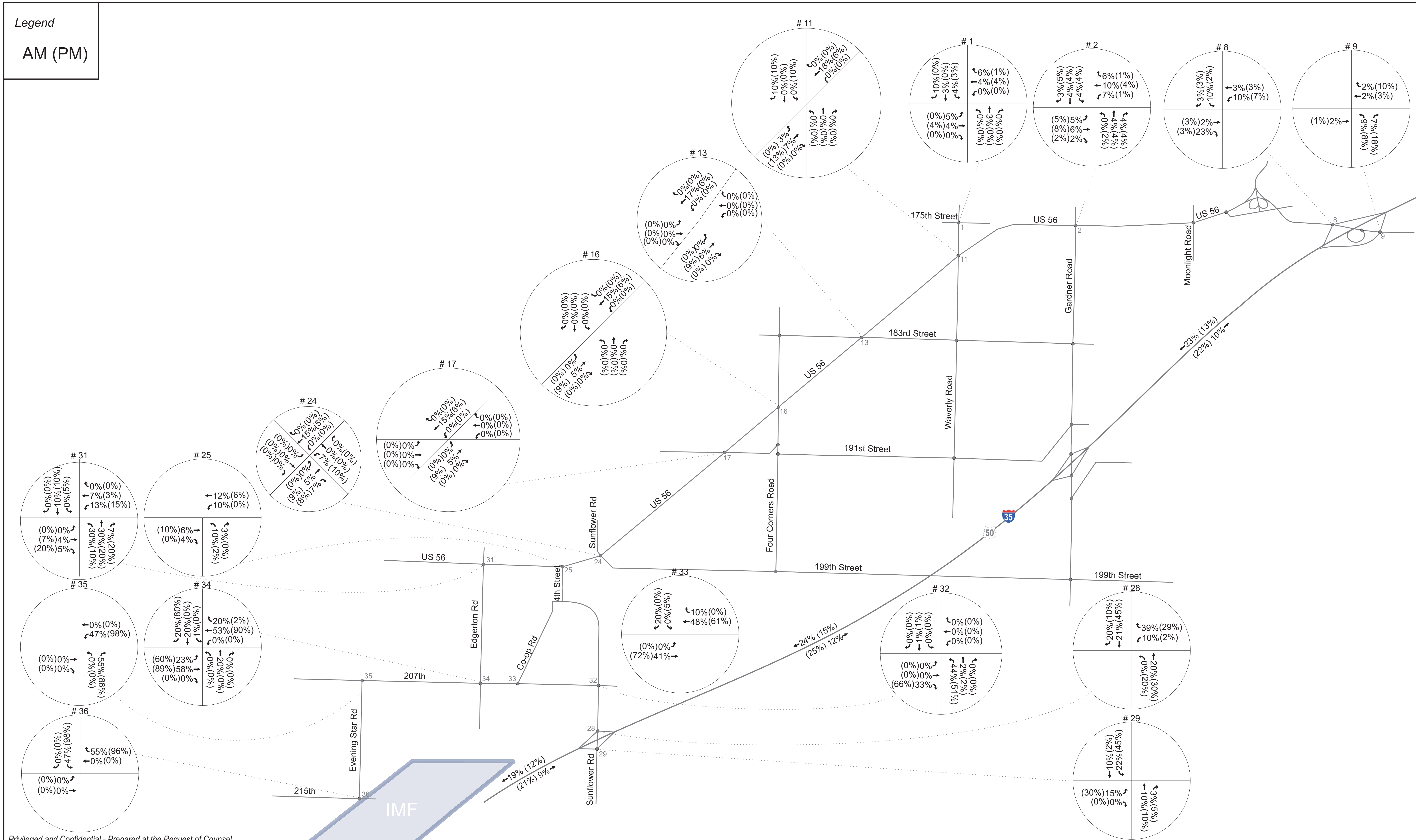

Figure C-13: 2010 Wellsville North Alternative
Peak Hour Truck Percentages

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BNSF RAILWAY

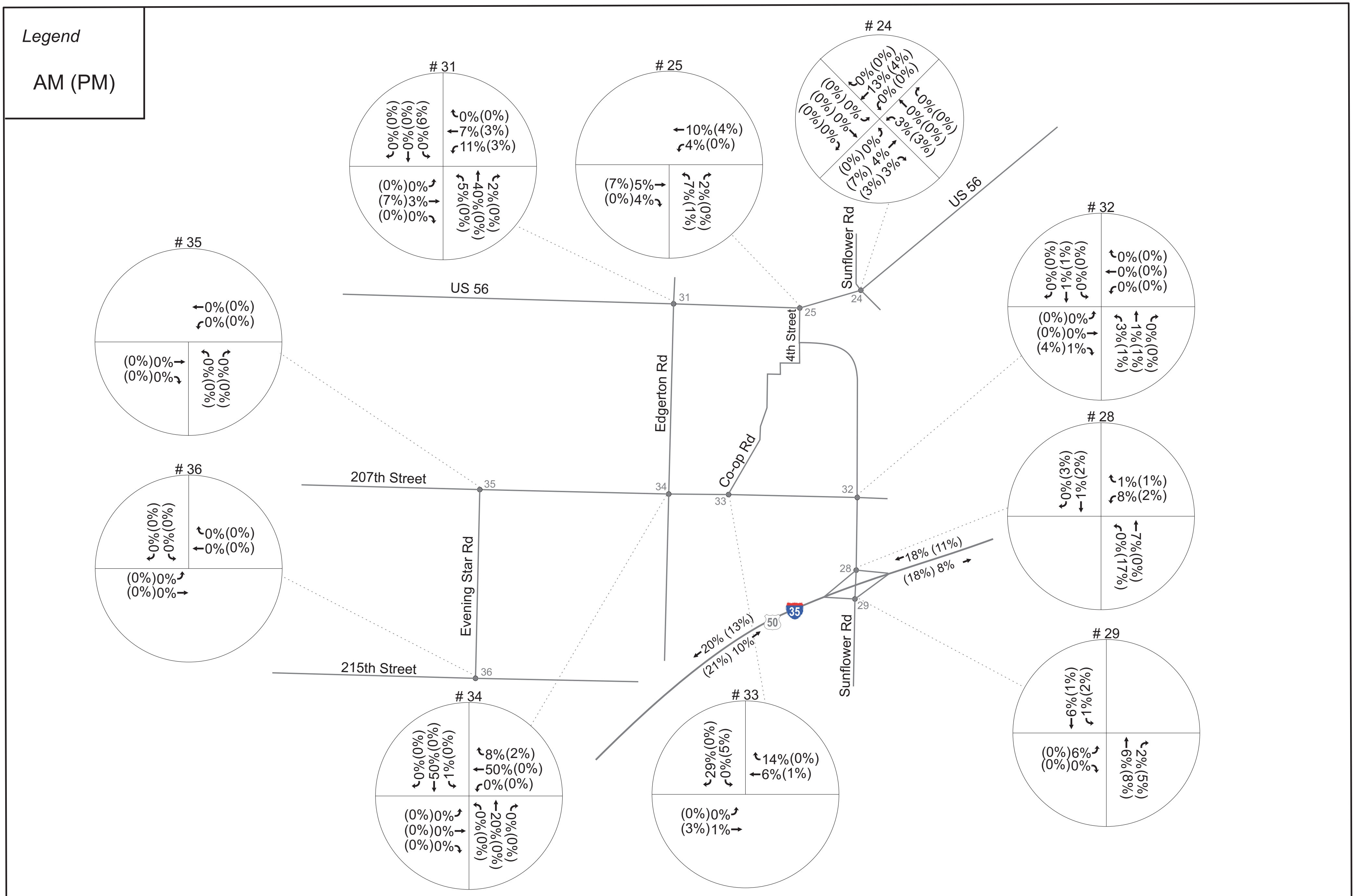

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Figure C-14: 2015 Wellsville North No Action
Peak Hour Truck Percentages

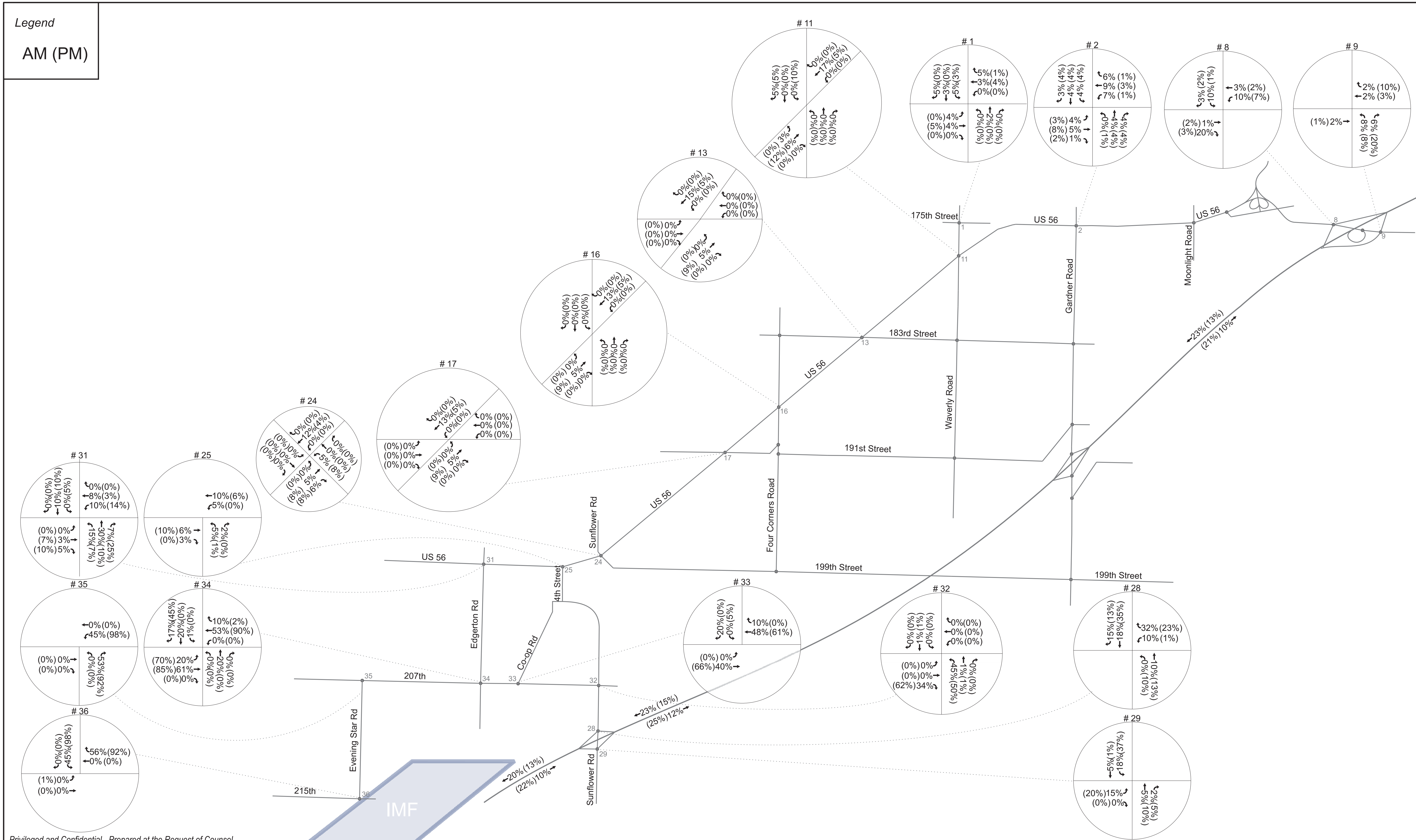

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Figure C-15: 2015 Wellsville North Alternative
Peak Hour Truck Percentages

BNSF RAILWAY

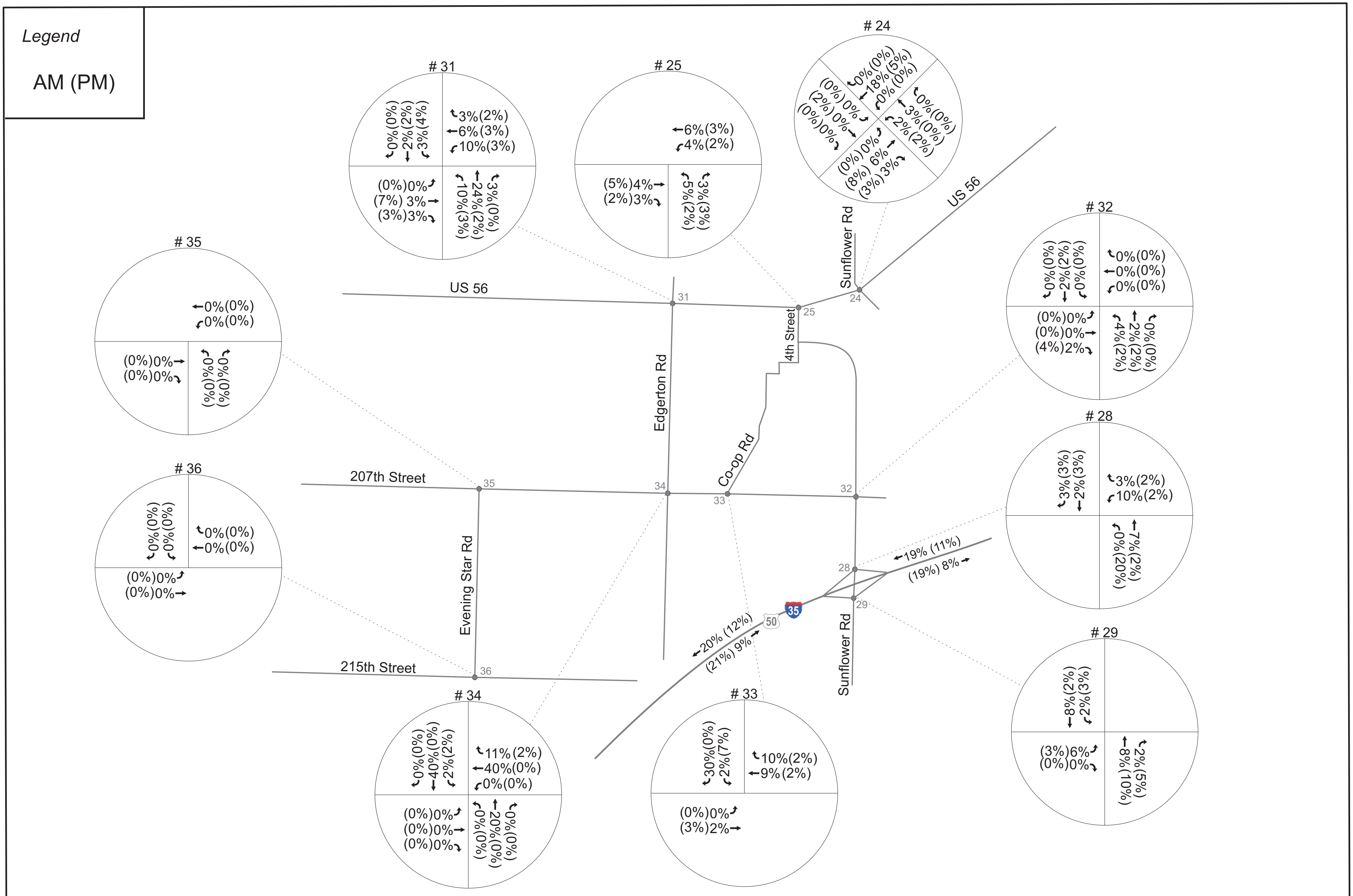

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Figure C-16: 2030 Wellsville North No Action
Peak Hour Truck Percentages

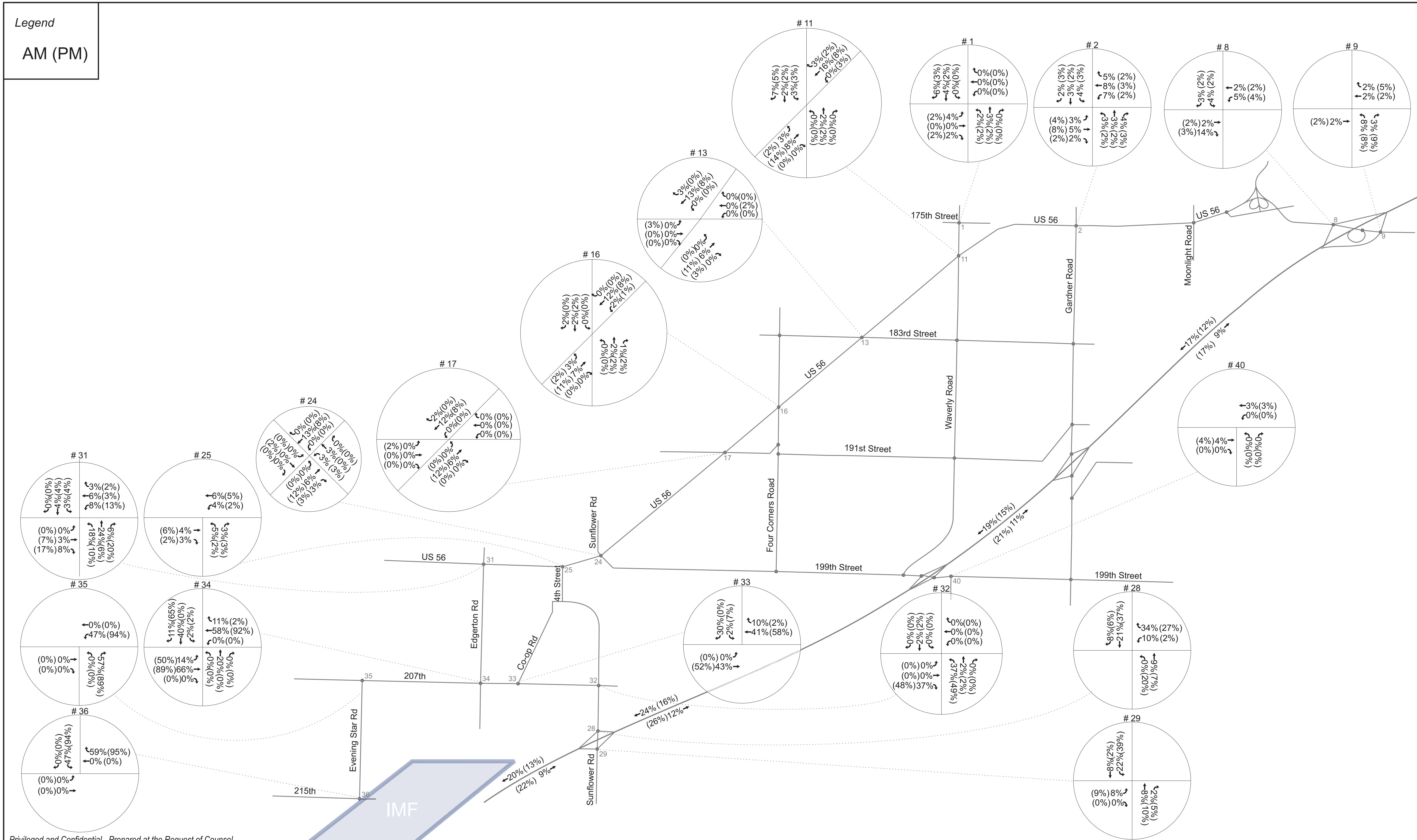

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Figure C-17: 2030 Wellsville North Alternative
Peak Hour Truck Percentages

BNSF RAILWAY

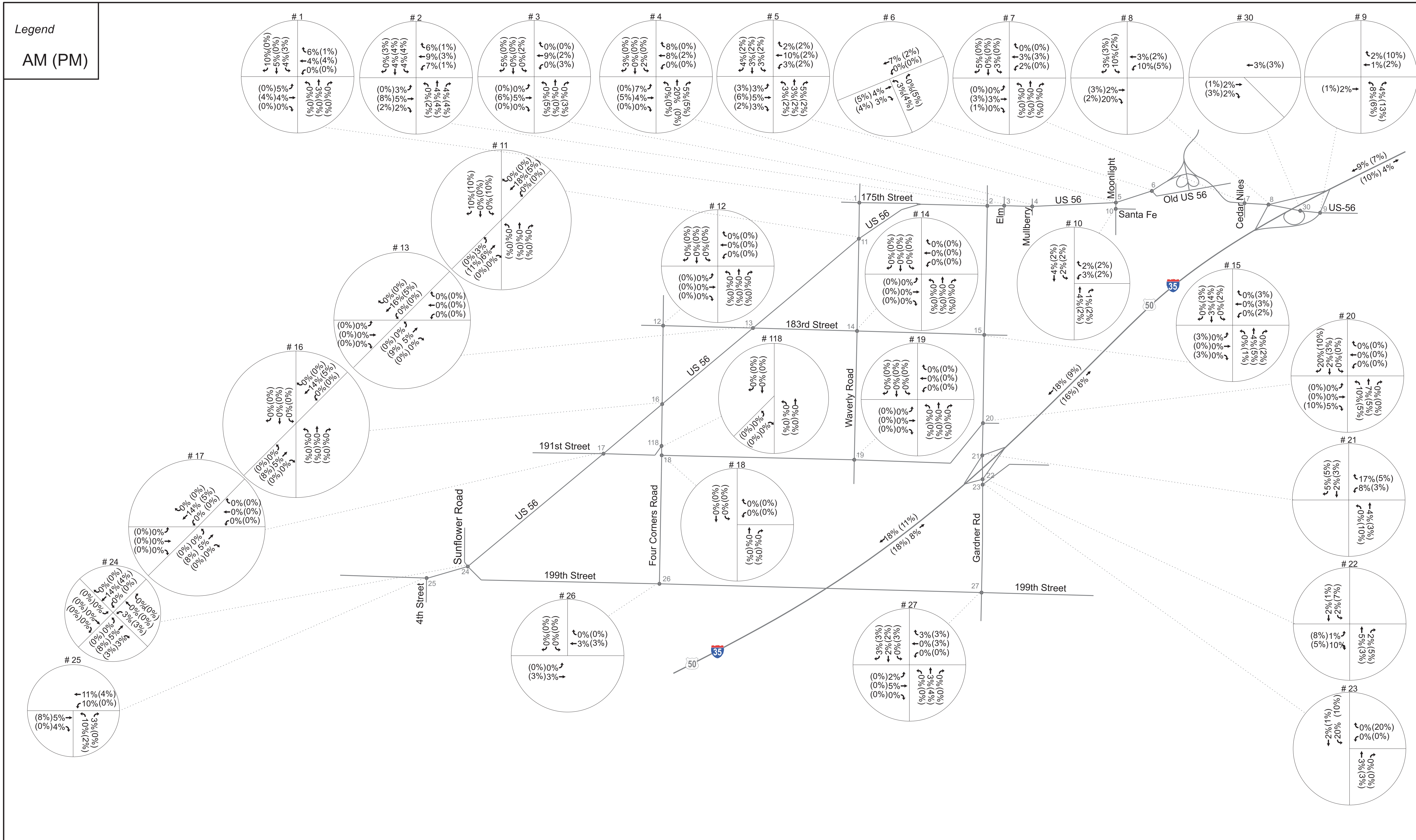

Figure C-3: 2010 Gardner No Action
Peak Hour Truck Percentages

Appendix D:
Results of Operational Analysis
Wellsville North Existing Conditions

Synchro Analysis

1. 2008 Wellsville North Existing Conditions

HCS Analysis

1. 2008 Wellsville North Existing Conditions

2008 Wellsville North Existing - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2008 Wellsville Existing

1: 175th Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	59	273	1	0	49	50	2	76	1	81	22	12
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	71	329	1	0	59	60	2	92	1	98	27	14
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	119			330			589	591	330	608	561	89
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	119			330			589	591	330	608	561	89
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.2	6.6	6.3
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.4
p0 queue free %	95			100			99	77	100	69	94	98
cM capacity (veh/h)	1450			1241			381	398	717	320	411	953

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	401	119	95	139
Volume Left	71	0	2	98
Volume Right	1	60	1	14
cSH	1450	1241	400	360
Volume to Capacity	0.05	0.00	0.24	0.39
Queue Length 95th (ft)	4	0	23	44
Control Delay (s)	1.7	0.0	16.8	21.1
Lane LOS	A		C	C
Approach Delay (s)	1.7	0.0	16.8	21.1
Approach LOS			C	C

Intersection Summary			
Average Delay	6.9		
Intersection Capacity Utilization	44.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Wellsville Existing

2: US 56 & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	37	522	58	91	200	98	68	300	179	133	192	21
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.99			0.96		1.00	0.94		1.00	0.99	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3392			3179		1805	1724		1719	1807	
Flt Permitted		0.90			0.65		0.61	1.00		0.30	1.00	
Satd. Flow (perm)		3054			2075		1153	1724		545	1807	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	43	600	67	105	230	113	78	345	206	153	221	24
RTOR Reduction (vph)	0	16	0	0	70	0	0	31	0	0	6	0
Lane Group Flow (vph)	0	694	0	0	378	0	78	520	0	153	239	0
Heavy Vehicles (%)	3%	5%	2%	8%	9%	6%	0%	4%	4%	5%	4%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		16.5			16.5		19.4	19.4		19.4	19.4	
Effective Green, g (s)		16.5			16.5		19.4	19.4		19.4	19.4	
Actuated g/C Ratio		0.35			0.35		0.41	0.41		0.41	0.41	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1059			719		470	703		222	736	
v/s Ratio Prot								c0.30			0.13	
v/s Ratio Perm		c0.23			0.18		0.07			0.28		
v/c Ratio		0.66			0.53		0.17	0.74		0.69	0.32	
Uniform Delay, d1		13.1			12.4		9.0	12.0		11.6	9.6	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.5			0.7		0.2	4.1		8.6	0.3	
Delay (s)		14.6			13.1		9.1	16.0		20.2	9.9	
Level of Service		B			B		A	B		C	A	
Approach Delay (s)		14.6			13.1			15.2			13.9	
Approach LOS		B			B			B			B	

Intersection Summary			
HCM Average Control Delay	14.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	47.6	Sum of lost time (s)	11.7
Intersection Capacity Utilization	83.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2008 Wellsville Existing

8: US-56 & I-35 SB Ramps

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	1621	41	22	445	0	0	0	0	51	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	0	1706	43	23	468	0	0	0	0	54	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		986										
pX, platoon unblocked				0.68			0.68	0.68	0.68	0.68	0.68	
vC, conflicting volume	468			1749			2008	2243	875	1368	2264	234
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	468			1151			1534	1880	0	587	1912	234
tC, single (s)	4.1			4.3			7.5	6.5	6.9	7.7	6.5	7.0
tC, 2 stage (s)												
tF (s)	2.2			2.3			3.5	4.0	3.3	3.6	4.0	3.3
p0 queue free %	100			94			100	100	100	78	100	100
cM capacity (veh/h)	1104			382			52	46	738	243	44	765

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	SB 1	SB 2
Volume Total	1138	612	23	234	234	54	0
Volume Left	0	0	23	0	0	54	0
Volume Right	0	43	0	0	0	0	0
cSH	1700	1700	382	1700	1700	243	1700
Volume to Capacity	0.67	0.36	0.06	0.14	0.14	0.22	0.00
Queue Length 95th (ft)	0	0	5	0	0	21	0
Control Delay (s)	0.0	0.0	15.0	0.0	0.0	24.0	0.0
Lane LOS			C			C	A
Approach Delay (s)	0.0		0.7			24.0	
Approach LOS						C	

Intersection Summary			
Average Delay	0.7		
Intersection Capacity Utilization	56.1%	ICU Level of Service	B
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Wellsville Existing

9: US-56 & I-35 NB Ramps

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	329	0	0	326	118	141	3	83	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	0	374	0	0	370	134	160	3	94	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	505			374			559	878	187	720	811	252
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	505			374			559	878	187	720	811	252
tC, single (s)	4.1			4.1			7.7	6.5	7.0	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.6	4.0	3.4	3.5	4.0	3.3
p0 queue free %	100			100			60	99	88	100	100	100
cM capacity (veh/h)	1070			1196			399	289	814	279	316	753

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	187	187	247	258	258
Volume Left	0	0	0	0	160
Volume Right	0	0	0	134	94
cSH	1700	1700	1700	1700	487
Volume to Capacity	0.11	0.11	0.15	0.15	0.53
Queue Length 95th (ft)	0	0	0	0	76
Control Delay (s)	0.0	0.0	0.0	0.0	20.4
Lane LOS					C
Approach Delay (s)	0.0		0.0		20.4
Approach LOS					C

Intersection Summary			
Average Delay	4.6		
Intersection Capacity Utilization	86.5%	ICU Level of Service	E
Analysis Period (min)	15		

2008 Wellsville North Existing - AM Peak Hour - Synchro Intersection LOS

11: Waverly Road & US 56

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	14	0	6	4	9	57	238	0	1	73	11
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	18	0	8	5	11	72	301	0	1	92	14
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	561	554	301	556	547	99	106			301		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	561	554	301	556	547	99	106			301		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.3	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.4	2.2			2.2		
p0 queue free %	100	96	100	98	99	99	95			100		
cM capacity (veh/h)	415	421	743	414	425	932	1472			1271		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	18	24	373	108
Volume Left	0	8	72	1
Volume Right	0	11	0	14
cSH	421	566	1472	1271
Volume to Capacity	0.04	0.04	0.05	0.00
Queue Length 95th (ft)	3	3	4	0
Control Delay (s)	13.9	11.6	1.8	0.1
Lane LOS	B	B	A	A
Approach Delay (s)	13.9	11.6	1.8	0.1
Approach LOS	B	B		

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	35.5%	ICU Level of Service	A
Analysis Period (min)	15		

13: 183rd Street & US 56

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	2	6	0	8	9	1	0	295	6	0	78	1
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	3	8	0	10	11	1	0	373	8	0	99	1
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	484	480	99	480	477	377	100			381		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	484	480	99	480	477	377	100			381		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	98	100	98	98	100	100			100		
cM capacity (veh/h)	487	488	962	493	490	674	1505			1189		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	10	23	381	100
Volume Left	3	10	0	0
Volume Right	0	1	8	1
cSH	488	499	1505	1189
Volume to Capacity	0.02	0.05	0.00	0.00
Queue Length 95th (ft)	2	4	0	0
Control Delay (s)	12.5	12.6	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	12.5	12.6	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	25.9%	ICU Level of Service	A
Analysis Period (min)	15		

16: Four Corners Road & US 56

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	1	3	7	0	5	4	11	294	0	1	85	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	1	4	9	0	7	5	14	387	0	1	112	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	539	530	387	541	530	112	112			387		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	539	530	387	541	530	112	112			387		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	99	99	100	99	99	99			100		
cM capacity (veh/h)	445	452	666	442	452	947	1490			1183		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	14	12	401	113
Volume Left	1	0	14	1
Volume Right	9	5	0	0
cSH	567	589	1490	1183
Volume to Capacity	0.03	0.02	0.01	0.00
Queue Length 95th (ft)	2	2	1	0
Control Delay (s)	11.5	11.2	0.4	0.1
Lane LOS	B	B	A	A
Approach Delay (s)	11.5	11.2	0.4	0.1
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	32.1%	ICU Level of Service	A
Analysis Period (min)	15		

17: 191st Street & US 56

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	1	0	0	1	0	302	1	0	85	1
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	6	6	1	0	0	1	0	392	1	0	110	1
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	505	505	111	508	505	393	112			394		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	505	505	111	508	505	393	112			394		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	99	100	100	100	100	100			100		
cM capacity (veh/h)	480	473	948	473	473	660	1491			1176		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	14	1	394	112
Volume Left	6	0	0	0
Volume Right	1	1	1	1
cSH	499	660	1491	1176
Volume to Capacity	0.03	0.00	0.00	0.00
Queue Length 95th (ft)	2	0	0	0
Control Delay (s)	12.4	10.5	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	12.4	10.5	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	27.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Wellsville Existing

24: Sunflower Road & US 56

AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	3	1	5	26	0	0	5	300	52	1	81	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	4	1	6	33	0	0	6	380	66	1	103	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	530	563	103	537	530	413	103			446		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	530	563	103	537	530	413	103			446		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	100	99	93	100	100	100			100		
cM capacity (veh/h)	461	436	958	446	455	644	1502			1125		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	11	33	452	104
Volume Left	4	33	6	1
Volume Right	6	0	66	0
cSH	642	446	1502	1125
Volume to Capacity	0.02	0.07	0.00	0.00
Queue Length 95th (ft)	1	6	0	0
Control Delay (s)	10.7	13.7	0.1	0.1
Lane LOS	B	B	A	A
Approach Delay (s)	10.7	13.7	0.1	0.1
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	32.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Wellsville Existing

25: US 56 & 4th Street

AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	331	46	7	105	12	26
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	424	59	9	135	15	33
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			483		606	454
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			483		606	454
tC, single (s)			4.2		6.5	6.2
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.3
p0 queue free %			99		97	94
cM capacity (veh/h)			1020		446	602

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	483	144	49
Volume Left	0	9	15
Volume Right	59	0	33
cSH	1700	1020	542
Volume to Capacity	0.28	0.01	0.09
Queue Length 95th (ft)	0	1	7
Control Delay (s)	0.0	0.6	12.3
Lane LOS		A	B
Approach Delay (s)	0.0	0.6	12.3
Approach LOS			B

Intersection Summary			
Average Delay	1.0		
Intersection Capacity Utilization	30.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Wellsville Existing

28: I-35 SB Ramps & Sunflower Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	8	0	27	1	16	0	0	205	3
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	0	0	0	9	0	31	1	18	0	0	236	3
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	289	258	237	258	260	18	239			18		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	289	258	237	258	260	18	239			18		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	99	100	97	100			100		
cM capacity (veh/h)	647	649	807	672	648	1054	1340			1611		

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	40	20	239
Volume Left	9	1	0
Volume Right	31	0	3
cSH	933	1340	1700
Volume to Capacity	0.04	0.00	0.14
Queue Length 95th (ft)	3	0	0
Control Delay (s)	9.0	0.5	0.0
Lane LOS	A	A	
Approach Delay (s)	9.0	0.5	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	21.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Wellsville Existing

29: I-35 NB Ramps & Sunflower Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	9	1	1	0	0	0	0	9	34	204	9	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	10	1	1	0	0	0	0	10	39	234	10	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	509	529	10	511	509	30	10			49		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	509	529	10	511	509	30	10			49		
tC, single (s)	7.2	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.6	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	100	100	100	100	100	100			85		
cM capacity (veh/h)	407	389	1077	420	399	1050	1622			1564		

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	13	49	245
Volume Left	10	0	234
Volume Right	1	39	0
cSH	430	1700	1564
Volume to Capacity	0.03	0.03	0.15
Queue Length 95th (ft)	2	0	13
Control Delay (s)	13.6	0.0	7.4
Lane LOS	B		A
Approach Delay (s)	13.6	0.0	7.4
Approach LOS	B		

Intersection Summary			
Average Delay	6.5		
Intersection Capacity Utilization	28.4%	ICU Level of Service	A
Analysis Period (min)	15		

2008 Wellsville North Existing - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2008 Wellsville Existing
31: US 56 & Edgerton Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	1	242	14	16	69	4	6	4	50	15	5	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1	263	15	17	75	4	7	4	54	16	5	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	79			278			388	387	271	441	392	77
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	79			278			388	387	271	441	392	77
tC, single (s)	4.1			4.2			7.3	7.0	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.3			3.7	4.4	3.3	3.5	4.0	3.3
p0 queue free %	100			99			99	99	93	97	99	100
cM capacity (veh/h)	1532			1224			535	472	768	483	539	989

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	279	97	65	22
Volume Left	1	17	7	16
Volume Right	15	4	54	0
cSH	1532	1224	708	496
Volume to Capacity	0.00	0.01	0.09	0.04
Queue Length 95th (ft)	0	1	8	3
Control Delay (s)	0.0	1.5	10.6	12.6
Lane LOS	A	A	B	B
Approach Delay (s)	0.0	1.5	10.6	12.6
Approach LOS			B	B

Intersection Summary			
Average Delay	2.4		
Intersection Capacity Utilization	28.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Wellsville Existing
32: 207th & Sunflower Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	98	1	0	3	14	29	0	2	108	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	0	124	1	0	4	18	37	0	3	137	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	218	214	137	338	214	37	137			37		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	218	214	137	338	214	37	137			37		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.2			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.3			2.2		
p0 queue free %	100	100	86	100	100	100	99			100		
cM capacity (veh/h)	732	678	915	530	678	1041	1417			1587		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	124	5	54	139
Volume Left	0	1	18	3
Volume Right	124	4	0	0
cSH	915	839	1417	1587
Volume to Capacity	0.14	0.01	0.01	0.00
Queue Length 95th (ft)	12	0	1	0
Control Delay (s)	9.6	9.3	2.5	0.1
Lane LOS	A	A	A	A
Approach Delay (s)	9.6	9.3	2.5	0.1
Approach LOS	A	A		

Intersection Summary			
Average Delay	4.3		
Intersection Capacity Utilization	21.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Wellsville Existing
33: 207th & COOP Rd — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	63	5	6	34	6
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	14	85	7	8	46	8
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	15				123	11
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	15				123	11
tC, single (s)	4.1				6.4	6.5
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.6
p0 queue free %	99				95	99
cM capacity (veh/h)	1616				870	987

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	99	15	54
Volume Left	14	0	46
Volume Right	0	8	8
cSH	1616	1700	885
Volume to Capacity	0.01	0.01	0.06
Queue Length 95th (ft)	1	0	5
Control Delay (s)	1.0	0.0	9.3
Lane LOS	A		A
Approach Delay (s)	1.0	0.0	9.3
Approach LOS			A

Intersection Summary			
Average Delay	3.6		
Intersection Capacity Utilization	20.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Wellsville Existing
34: 207th & Edgerton Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	4	5	0	0	2	10	0	4	0	62	2	2
Peak Hour Factor	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Hourly flow rate (vph)	6	8	0	0	3	15	0	6	0	94	3	3

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	14	18	6	100
Volume Left (vph)	6	0	0	94
Volume Right (vph)	0	15	0	3
Hadj (s)	0.09	-0.07	0.42	0.23
Departure Headway (s)	4.2	4.1	4.5	4.2
Degree Utilization, x	0.02	0.02	0.01	0.12
Capacity (veh/h)	822	856	781	846
Control Delay (s)	7.3	7.2	7.5	7.8
Approach Delay (s)	7.3	7.2	7.5	7.8
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.6		
HCM Level of Service	A		
Intersection Capacity Utilization	20.8%	ICU Level of Service	A
Analysis Period (min)	15		

2008 Wellsville North Existing - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2008 Wellsville Existing
35: 207th & Evening Star Rd — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	4	0	1	4	0	3
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	8	0	2	8	0	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			8		20	8
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			8		20	8
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	99
cM capacity (veh/h)			1625		1001	1080

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	8	10	6
Volume Left	0	2	0
Volume Right	0	0	6
cSH	1700	1625	1080
Volume to Capacity	0.00	0.00	0.01
Queue Length 95th (ft)	0	0	0
Control Delay (s)	0.0	1.5	8.4
Lane LOS		A	A
Approach Delay (s)	0.0	1.5	8.4
Approach LOS			A

Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Wellsville Existing
36: 215th & Evening Star Rd — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	0	0	0	1	1
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	0	0	0	2	2
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	0				0	0
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	0				0	0
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	100
cM capacity (veh/h)	1636				1029	1091

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	0	0	4
Volume Left	0	0	2
Volume Right	0	0	2
cSH	1700	1700	1059
Volume to Capacity	0.00	0.00	0.00
Queue Length 95th (ft)	0	0	0
Control Delay (s)	0.0	0.0	8.4
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.4
Approach LOS			A

Intersection Summary			
Average Delay	8.4		
Intersection Capacity Utilization	6.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Wellsville Existing

1: 175th Street & Waverly Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	12	85	2	1	267	77	8	18	1	29	20	20
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	14	98	2	1	307	89	9	21	1	33	23	23
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	395			100			514	524	99	491	481	351
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	395			100			514	524	99	491	481	351
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			100			98	95	100	93	95	97
cM capacity (veh/h)	1163			1505			433	452	962	465	478	692

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	114	397	31	79
Volume Left	14	1	9	33
Volume Right	2	89	1	23
cSH	1163	1505	455	519
Volume to Capacity	0.01	0.00	0.07	0.15
Queue Length 95th (ft)	1	0	5	13
Control Delay (s)	1.1	0.0	13.5	13.2
Lane LOS	A	A	B	B
Approach Delay (s)	1.1	0.0	13.5	13.2
Approach LOS			B	B

Intersection Summary			
Average Delay	2.6		
Intersection Capacity Utilization	31.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Wellsville Existing

2: US 56 & Gardner Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	21	254	48	202	592	208	54	143	134	133	138	37
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.98			0.97		1.00	0.93		1.00	0.97	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3297			3389		1770	1694		1736	1777	
Flt Permitted		0.86			0.79		0.64	1.00		0.53	1.00	
Satd. Flow (perm)		2859			2699		1193	1694		973	1777	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	22	270	51	215	630	221	57	152	143	141	147	39
RTOR Reduction (vph)	0	24	0	0	39	0	0	60	0	0	17	0
Lane Group Flow (vph)	0	319	0	0	1027	0	57	235	0	141	169	0
Heavy Vehicles (%)	2%	8%	2%	1%	3%	1%	2%	4%	4%	4%	4%	2%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		23.5			23.5		13.6	13.6		13.6	13.6	
Effective Green, g (s)		23.5			23.5		13.6	13.6		13.6	13.6	
Actuated g/C Ratio		0.48			0.48		0.28	0.28		0.28	0.28	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1377			1300		332	472		271	495	
v/s Ratio Prot								0.14			0.10	
v/s Ratio Perm		0.11			c0.38		0.05			c0.14		
v/c Ratio		0.23			0.79		0.17	0.50		0.52	0.34	
Uniform Delay, d1		7.4			10.6		13.3	14.7		14.8	14.0	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.1			3.3		0.2	0.8		1.8	0.4	
Delay (s)		7.5			13.9		13.6	15.6		16.6	14.4	
Level of Service		A			B		B	B		B	B	
Approach Delay (s)		7.5			13.9			15.2			15.4	
Approach LOS		A			B			B			B	

Intersection Summary			
HCM Average Control Delay	13.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	48.8	Sum of lost time (s)	11.7
Intersection Capacity Utilization	81.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2008 Wellsville Existing

8: US-56 & I-35 SB Ramps

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	1247	196	96	437	0	0	0	0	114	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	1341	211	103	470	0	0	0	0	123	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		986										
pX, platoon unblocked				0.71			0.71	0.71	0.71	0.71	0.71	
vC, conflicting volume	470			1552			1888	2123	776	1347	2228	235
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	470			947			1423	1756	0	656	1905	235
tC, single (s)	4.1			4.2			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			79			100	100	100	41	100	100
cM capacity (veh/h)	1102			496			58	48	769	208	39	767

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	SB 1	SB 2
Volume Total	894	658	103	235	235	123	0
Volume Left	0	0	103	0	0	123	0
Volume Right	0	211	0	0	0	0	0
cSH	1700	1700	496	1700	1700	208	1700
Volume to Capacity	0.53	0.39	0.21	0.14	0.14	0.59	0.00
Queue Length 95th (ft)	0	0	19	0	0	82	0
Control Delay (s)	0.0	0.0	14.2	0.0	0.0	44.6	0.0
Lane LOS			B			E	A
Approach Delay (s)	0.0		2.6			44.6	
Approach LOS						E	

Intersection Summary			
Average Delay	3.1		
Intersection Capacity Utilization	62.4%	ICU Level of Service	B
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Wellsville Existing

9: US-56 & I-35 NB Ramps

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	437	0	0	462	18	71	2	34	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	0	497	0	0	525	20	81	2	39	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	545			497			759	1042	248	823	1032	273
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	545			497			759	1042	248	823	1032	273
tC, single (s)	4.1			4.1			7.6	6.5	7.2	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.6	4.0	3.4	3.5	4.0	3.3
p0 queue free %	100			100			72	99	95	100	100	100
cM capacity (veh/h)	1034			1078			287	232	714	252	235	731

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	248	248	350	195	122
Volume Left	0	0	0	0	81
Volume Right	0	0	0	20	39
cSH	1700	1700	1700	1700	352
Volume to Capacity	0.15	0.15	0.21	0.11	0.35
Queue Length 95th (ft)	0	0	0	0	38
Control Delay (s)	0.0	0.0	0.0	0.0	20.5
Lane LOS					C
Approach Delay (s)	0.0		0.0		20.5
Approach LOS					C

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	60.5%	ICU Level of Service	B
Analysis Period (min)	15		

2008 Wellsville North Existing - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study
11: Waverly Road & US 56

2008 Wellsville Existing
PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✣			✣			✣			✣	
Volume (veh/h)	0	11	3	7	3	12	15	112	0	2	248	1
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	0	12	3	8	3	14	17	127	0	2	282	1
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	464	449	127	458	448	282	283			127		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	464	449	127	458	448	282	283			127		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.3	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.4	2.2			2.2		
p0 queue free %	100	97	100	98	99	98	99			100		
cM capacity (veh/h)	494	498	928	477	497	742	1279			1471		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	16	25	144	285
Volume Left	0	8	17	2
Volume Right	3	14	0	1
cSH	553	596	1279	1471
Volume to Capacity	0.03	0.04	0.01	0.00
Queue Length 95th (ft)	2	3	1	0
Control Delay (s)	11.7	11.3	1.0	0.1
Lane LOS	B	B	A	A
Approach Delay (s)	11.7	11.3	1.0	0.1
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	30.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study
13: 183rd Street & US 56

2008 Wellsville Existing
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✣			✣			✣			✣	
Volume (veh/h)	2	4	0	5	8	0	0	134	12	0	256	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	2	4	0	5	8	0	0	141	13	0	269	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	421	423	269	419	417	147	269			154		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	421	423	269	419	417	147	269			154		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	99	100	99	98	100	100			100		
cM capacity (veh/h)	540	521	774	545	525	905	1306			1439		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	6	14	154	269
Volume Left	2	5	0	0
Volume Right	0	0	13	0
cSH	527	532	1306	1439
Volume to Capacity	0.01	0.03	0.00	0.00
Queue Length 95th (ft)	1	2	0	0
Control Delay (s)	11.9	11.9	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	11.9	11.9	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	23.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study
16: Four Corners Road & US 56

2008 Wellsville Existing
PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✣			✣			✣			✣	
Volume (veh/h)	2	1	1	0	1	3	3	144	1	4	265	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	2	1	1	0	1	3	3	162	1	4	298	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	480	476	162	478	476	298	298			163		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	480	476	162	478	476	298	298			163		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	100	100	100	100			100		
cM capacity (veh/h)	494	488	888	498	488	739	1258			1410		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	4	4	166	302
Volume Left	2	0	3	4
Volume Right	1	3	1	0
cSH	554	655	1258	1410
Volume to Capacity	0.01	0.01	0.00	0.00
Queue Length 95th (ft)	1	1	0	0
Control Delay (s)	11.6	10.5	0.2	0.1
Lane LOS	B	B	A	A
Approach Delay (s)	11.6	10.5	0.2	0.1
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	26.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study
17: 191st Street & US 56

2008 Wellsville Existing
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✣			✣			✣			✣	
Volume (veh/h)	0	0	0	2	3	0	0	141	0	0	267	4
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	0	0	0	2	3	0	0	162	0	0	307	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	473	471	309	471	474	162	311			162		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	473	471	309	471	474	162	311			162		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	100	99	100	100			100		
cM capacity (veh/h)	502	494	736	506	488	888	1260			1429		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	0	6	162	311
Volume Left	0	2	0	0
Volume Right	0	0	0	5
cSH	1700	495	1260	1429
Volume to Capacity	0.00	0.01	0.00	0.00
Queue Length 95th (ft)	0	1	0	0
Control Delay (s)	0.0	12.4	0.0	0.0
Lane LOS	A	B		
Approach Delay (s)	0.0	12.4	0.0	0.0
Approach LOS	A	B		

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	24.3%	ICU Level of Service	A
Analysis Period (min)	15		

2008 Wellsville North Existing - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2008 Wellsville Existing

24: Sunflower Road & US 56

PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	2	6	28	1	0	7	138	31	0	279	1
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	0	2	6	30	1	0	7	147	33	0	297	1
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	476	492	297	483	476	163	298			180		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	476	492	297	483	476	163	298			180		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	99	94	100	100	99			100		
cM capacity (veh/h)	499	478	742	486	488	887	1269			1408		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	9	31	187	298
Volume Left	0	30	7	0
Volume Right	6	0	33	1
cSH	652	486	1269	1700
Volume to Capacity	0.01	0.06	0.01	0.18
Queue Length 95th (ft)	1	5	0	0
Control Delay (s)	10.6	12.9	0.4	0.0
Lane LOS	B	B	A	
Approach Delay (s)	10.6	12.9	0.4	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	29.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Wellsville Existing

25: US 56 & 4th Street

PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	158	17	21	292	60	18
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	170	18	23	314	65	19
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			188		538	179
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			188		538	179
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		87	98
cM capacity (veh/h)			1386		496	864

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	188	337	84
Volume Left	0	23	65
Volume Right	18	0	19
cSH	1700	1386	550
Volume to Capacity	0.11	0.02	0.15
Queue Length 95th (ft)	0	1	13
Control Delay (s)	0.0	0.7	12.7
Lane LOS		A	B
Approach Delay (s)	0.0	0.7	12.7
Approach LOS			B

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	40.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Wellsville Existing

28: I-35 SB Ramps & Sunflower Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	52	0	184	5	6	0	0	76	20
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	0	0	0	59	0	209	6	7	0	0	86	23
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	325	116	98	116	127	7	109			7		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	325	116	98	116	127	7	109			7		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.3			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.4			2.2		
p0 queue free %	100	100	100	93	100	81	100			100		
cM capacity (veh/h)	507	775	964	858	764	1076	1376			1627		

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	268	12	109
Volume Left	59	6	0
Volume Right	209	0	23
cSH	1019	1376	1700
Volume to Capacity	0.26	0.00	0.06
Queue Length 95th (ft)	27	0	0
Control Delay (s)	9.8	3.5	0.0
Lane LOS	A	A	
Approach Delay (s)	9.8	3.5	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	6.8		
Intersection Capacity Utilization	26.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Wellsville Existing

29: I-35 NB Ramps & Sunflower Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	3	0	2	0	0	0	0	8	16	71	57	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	3	0	2	0	0	0	0	9	18	79	63	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	239	248	63	241	239	18	63			27		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	239	248	63	241	239	18	63			27		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	100	100	100	100			95		
cM capacity (veh/h)	692	625	1007	688	632	1067	1552			1574		

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	6	27	142
Volume Left	3	0	79
Volume Right	2	18	0
cSH	791	1700	1574
Volume to Capacity	0.01	0.02	0.05
Queue Length 95th (ft)	1	0	4
Control Delay (s)	9.6	0.0	4.3
Lane LOS	A		A
Approach Delay (s)	9.6	0.0	4.3
Approach LOS	A		

Intersection Summary			
Average Delay	3.8		
Intersection Capacity Utilization	23.6%	ICU Level of Service	A
Analysis Period (min)	15		

2008 Wellsville North Existing - PM Peak Hour - Synchro Intersection LOS

31: US 56 & Edgerton Rd

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	3	104	5	33	211	9	15	4	11	14	5	3
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
Hourly flow rate (vph)	3	121	6	38	245	10	17	5	13	16	6	3
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	256			127			465	463	124	473	461	251
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	256			127			465	463	124	473	461	251
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.2	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.6	4.0	3.3
p0 queue free %	100			97			96	99	99	97	99	100
cM capacity (veh/h)	1321			1453			493	484	932	472	486	793

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	130	294	35	26
Volume Left	3	38	17	16
Volume Right	6	10	13	3
cSH	1321	1453	595	503
Volume to Capacity	0.00	0.03	0.06	0.05
Queue Length 95th (ft)	0	2	5	4
Control Delay (s)	0.2	1.2	11.4	12.5
Lane LOS	A	A	B	B
Approach Delay (s)	0.2	1.2	11.4	12.5
Approach LOS			B	B

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	30.1%	ICU Level of Service	A
Analysis Period (min)	15		

32: 207th & Sunflower Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	1	0	34	2	1	4	82	103	3	2	59	1
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	1	0	38	2	1	4	91	114	3	2	66	1
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	374	371	66	407	369	116	67			118		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	374	371	66	407	369	116	67			118		
tC, single (s)	7.1	6.5	6.3	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.4	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	96	100	100	100	94			100		
cM capacity (veh/h)	556	528	987	512	529	942	1541			1483		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	39	8	209	69
Volume Left	1	2	91	2
Volume Right	38	4	3	1
cSH	965	697	1541	1483
Volume to Capacity	0.04	0.01	0.06	0.00
Queue Length 95th (ft)	3	1	5	0
Control Delay (s)	8.9	10.2	3.5	0.3
Lane LOS	A	B	A	A
Approach Delay (s)	8.9	10.2	3.5	0.3
Approach LOS	A	B		

Intersection Summary			
Average Delay	3.6		
Intersection Capacity Utilization	26.8%	ICU Level of Service	A
Analysis Period (min)	15		

33: 207th & COOP Rd

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	6	18	51	33	17	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.81	0.81	0.81	0.81	0.81	0.81
Hourly flow rate (vph)	7	22	63	41	21	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	104				120	83
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	104				120	83
tC, single (s)	4.1				6.5	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.6	3.3
p0 queue free %	100				98	99
cM capacity (veh/h)	1501				861	982

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	30	104	27
Volume Left	7	0	21
Volume Right	0	41	6
cSH	1501	1700	886
Volume to Capacity	0.00	0.06	0.03
Queue Length 95th (ft)	0	0	2
Control Delay (s)	1.9	0.0	9.2
Lane LOS	A		A
Approach Delay (s)	1.9	0.0	9.2
Approach LOS			A

Intersection Summary			
Average Delay	1.9		
Intersection Capacity Utilization	16.2%	ICU Level of Service	A
Analysis Period (min)	15		

34: 207th & Edgerton Rd

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	3	7	0	4	6	46	1	3	1	16	1	4
Peak Hour Factor	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Hourly flow rate (vph)	4	8	0	5	7	54	1	4	1	19	1	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	12	66	6	25
Volume Left (vph)	4	5	1	19
Volume Right (vph)	0	54	1	5
Hadj (s)	0.06	-0.45	-0.08	0.04
Departure Headway (s)	4.1	3.5	4.0	4.1
Degree Utilization, x	0.01	0.06	0.01	0.03
Capacity (veh/h)	867	1006	872	859
Control Delay (s)	7.1	6.8	7.0	7.2
Approach Delay (s)	7.1	6.8	7.0	7.2
Approach LOS	A	A	A	A

Intersection Summary			
Delay	6.9		
HCM Level of Service	A		
Intersection Capacity Utilization	13.7%	ICU Level of Service	A
Analysis Period (min)	15		

2008 Wellsville North Existing - PM Peak Hour - Synchro Intersection LOS

35: 207th & Evening Star Rd

PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	9	1	2	9	1	1
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.68	0.68	0.68	0.68	0.68	0.68
Hourly flow rate (vph)	13	1	3	13	1	1
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			15		33	14
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			15		33	14
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			1616		984	1072

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	15	16	3
Volume Left	0	3	1
Volume Right	1	0	1
cSH	1700	1616	1026
Volume to Capacity	0.01	0.00	0.00
Queue Length 95th (ft)	0	0	0
Control Delay (s)	0.0	1.3	8.5
Lane LOS		A	A
Approach Delay (s)	0.0	1.3	8.5
Approach LOS			A

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2008 Wellsville Existing

36: 215th & Evening Star Rd

PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	1	1	0	1	1
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	0	1	1	0	1	1
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1				2	1
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1				2	1
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	100
cM capacity (veh/h)	1635				1026	1090

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	1	1	2
Volume Left	0	0	1
Volume Right	0	0	1
cSH	1635	1700	1057
Volume to Capacity	0.00	0.00	0.00
Queue Length 95th (ft)	0	0	0
Control Delay (s)	0.0	0.0	8.4
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.4
Approach LOS			A

Intersection Summary			
Average Delay	4.2		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

2008 Wellsville North Existing - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

______________Operational Analysis______________

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/18/2008 10:15:14 AM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: Edgerton Road to Sunflower Road
Jurisdiction:
Analysis Year: 2008
Description: NEPA Traffic Study

______________Flow Inputs and Adjustments______________

Volume, V	1130	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	314	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	656	pc/h/ln

______________Speed Inputs and Adjustments______________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

______________LOS and Performance Measures______________

Flow rate, vp	656	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	9.4	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

______________Operational Analysis______________

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/18/2008 10:15:14 AM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: Gardner Road to US 56
Jurisdiction: KDOT
Analysis Year: 2008
Description: NEPA Traffic Study

______________Flow Inputs and Adjustments______________

Volume, V	1830	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	508	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1062	pc/h/ln

______________Speed Inputs and Adjustments______________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

______________LOS and Performance Measures______________

Flow rate, vp	1062	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	15.2	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2008 Wellsville North Existing - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/18/2008 10:15:14 AM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Sunflower Road to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2008

Description: NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	1360	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	378	v
Trucks and buses	8	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.962	
Driver population factor, fp	1.00	
Flow rate, vp	786	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	786	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	11.2	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/18/2008 10:15:14 AM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	US 56 to 151st Street
Jurisdiction:	KDOT
Analysis Year:	2008

Description: NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	3060	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	850	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1751	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	1751	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	68.4	mi/h
Number of lanes, N	2	
Density, D	25.6	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/18/2008 10:15:14 AM
Analysis Time Period: AM
Freeway/Direction: I-35 Southbound
From/To: 151Street to US 56
Jurisdiction: KDOT
Analysis Year: 2008
Description: NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	1400	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	389	v
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.948	
Driver population factor, fp	1.00	
Flow rate, vp	821	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	821	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	11.7	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/18/2008 10:15:14 AM
Analysis Time Period: AM
Freeway/Direction: I-35 Southbound
From/To: Gardner Road to Sunflower Road
Jurisdiction: KDOT
Analysis Year: 2008
Description: NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	500	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	139	v
Trucks and buses	18	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.917	
Driver population factor, fp	1.00	
Flow rate, vp	303	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	303	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	4.3	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

2008 Wellsville North Existing - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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Phone:                                    Fax:
E-mail:

_________________________Operational Analysis__________________________________

Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         3/18/2008 10:15:14 AM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Southbound
From/To:                Sunflower Road to Edgerton Road
Jurisdiction:
Analysis Year:          2008
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                 470           veh/h
Peak-hour factor, PHF                     0.90
Peak 15-min volume, v15                   131           v
Trucks and buses                          18            %
Recreational vehicles                     0             %
Terrain type:                             Level
    Grade                                 0.00          %
    Segment length                        0.00          mi
Trucks and buses PCE, ET                  1.5
Recreational vehicle PCE, ER              1.2
Heavy vehicle adjustment, fHV             0.917
Driver population factor, fp              1.00
Flow rate, vp                             285           pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                12.0          ft
Right-shoulder lateral clearance          6.0           ft
Interchange density                       0.50          interchange/mi
Number of lanes, N                        2
Free-flow speed:                          Measured
     FFS or BFFS                          70.0          mi/h
Lane width adjustment, fLW                0.0           mi/h
Lateral clearance adjustment, fLC         0.0           mi/h
Interchange density adjustment, fID       0.0           mi/h
Number of lanes adjustment, fN            0.0           mi/h
Free-flow speed, FFS                      70.0          mi/h
                                          Rural Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                             285           pc/h/ln
Free-flow speed, FFS                      70.0          mi/h
Average passenger-car speed, S            70.0          mi/h
Number of lanes, N                        2
Density, D                                4.1           pc/mi/ln
Level of service, LOS                     A

  Overall results are not computed when free-flow speed is less than 55 mph.
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HCS+: Basic Freeway Segments Release 5.21

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Phone:                                    Fax:
E-mail:

_________________________Operational Analysis__________________________________

Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         3/18/2008 10:15:14 AM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Southbound
From/To:                US 56 to Gardner Road
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                 540           veh/h
Peak-hour factor, PHF                     0.90
Peak 15-min volume, v15                   150           v
Trucks and buses                          21            %
Recreational vehicles                     0             %
Terrain type:                             Level
    Grade                                 0.00          %
    Segment length                        0.00          mi
Trucks and buses PCE, ET                  1.5
Recreational vehicle PCE, ER              1.2
Heavy vehicle adjustment, fHV             0.905
Driver population factor, fp              1.00
Flow rate, vp                             332           pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                12.0          ft
Right-shoulder lateral clearance          6.0           ft
Interchange density                       0.50          interchange/mi
Number of lanes, N                        2
Free-flow speed:                          Measured
     FFS or BFFS                          70.0          mi/h
Lane width adjustment, fLW                0.0           mi/h
Lateral clearance adjustment, fLC         0.0           mi/h
Interchange density adjustment, fID       0.0           mi/h
Number of lanes adjustment, fN            0.0           mi/h
Free-flow speed, FFS                      70.0          mi/h
                                          Rural Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                             332           pc/h/ln
Free-flow speed, FFS                      70.0          mi/h
Average passenger-car speed, S            70.0          mi/h
Number of lanes, N                        2
Density, D                                4.7           pc/mi/ln
Level of service, LOS                     A

  Overall results are not computed when free-flow speed is less than 55 mph.
```

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E-mail:

______Operational Analysis______

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/18/2008 10:15:14 AM
Analysis Time Period: PM
Freeway/Direction: I-35 Northbound
From/To: Edgerton Road to Sunflower Road
Jurisdiction:
Analysis Year: 2008
Description: NEPA Traffic Study

______Flow Inputs and Adjustments______

Volume, V	650	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	181	v
Trucks and buses	20	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.909	
Driver population factor, fp	1.00	
Flow rate, vp	397	pc/h/ln

______Speed Inputs and Adjustments______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

______LOS and Performance Measures______

Flow rate, vp	397	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	5.7	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

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E-mail:

______Operational Analysis______

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/18/2008 10:15:14 AM
Analysis Time Period: PM
Freeway/Direction: I-35 Northbound
From/To: Gardner Road to US 56
Jurisdiction: KDOT
Analysis Year: 2008
Description: NEPA Traffic Study

______Flow Inputs and Adjustments______

Volume, V	920	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	256	v
Trucks and buses	16	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.926	
Driver population factor, fp	1.00	
Flow rate, vp	552	pc/h/ln

______Speed Inputs and Adjustments______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

______LOS and Performance Measures______

Flow rate, vp	552	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	7.9	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

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__________________________Operational Analysis___________________________________

Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         3/18/2008 10:15:14 AM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Northbound
From/To:                Sunflower Road to Gardner Road
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________Flow Inputs and Adjustments____________________________

Volume, V                                730           veh/h
Peak-hour factor, PHF                    0.90
Peak 15-min volume, v15                  203           v
Trucks and buses                         18            %
Recreational vehicles                    0             %
Terrain type:                            Level
    Grade                                0.00          %
    Segment length                       0.00          mi
Trucks and buses PCE, ET                 1.5
Recreational vehicle PCE, ER             1.2
Heavy vehicle adjustment, fHV            0.917
Driver population factor, fp             1.00
Flow rate, vp                            442           pc/h/ln

__________________________Speed Inputs and Adjustments___________________________

Lane width                               12.0          ft
Right-shoulder lateral clearance         6.0           ft
Interchange density                      0.50          interchange/mi
Number of lanes, N                       2
Free-flow speed:                         Measured
     FFS or BFFS                         70.0          mi/h
Lane width adjustment, fLW               0.0           mi/h
Lateral clearance adjustment, fLC        0.0           mi/h
Interchange density adjustment, fID      0.0           mi/h
Number of lanes adjustment, fN           0.0           mi/h
Free-flow speed, FFS                     70.0          mi/h
                                         Rural Freeway

__________________________LOS and Performance Measures___________________________

Flow rate, vp                            442           pc/h/ln
Free-flow speed, FFS                     70.0          mi/h
Average passenger-car speed, S           70.0          mi/h
Number of lanes, N                       2
Density, D                               6.3           pc/mi/ln
Level of service, LOS                    A

  Overall results are not computed when free-flow speed is less than 55 mph.
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HCS+: Basic Freeway Segments Release 5.21

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__________________________Operational Analysis___________________________________

Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         3/18/2008 10:15:14 AM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Northbound
From/To:                US 56 to 151st Street
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________Flow Inputs and Adjustments____________________________

Volume, V                                1750          veh/h
Peak-hour factor, PHF                    0.90
Peak 15-min volume, v15                  486           v
Trucks and buses                         9             %
Recreational vehicles                    0             %
Terrain type:                            Level
    Grade                                0.00          %
    Segment length                       0.00          mi
Trucks and buses PCE, ET                 1.5
Recreational vehicle PCE, ER             1.2
Heavy vehicle adjustment, fHV            0.957
Driver population factor, fp             1.00
Flow rate, vp                            1016          pc/h/ln

__________________________Speed Inputs and Adjustments___________________________

Lane width                               12.0          ft
Right-shoulder lateral clearance         6.0           ft
Interchange density                      0.50          interchange/mi
Number of lanes, N                       2
Free-flow speed:                         Measured
     FFS or BFFS                         70.0          mi/h
Lane width adjustment, fLW               0.0           mi/h
Lateral clearance adjustment, fLC        0.0           mi/h
Interchange density adjustment, fID      0.0           mi/h
Number of lanes adjustment, fN           0.0           mi/h
Free-flow speed, FFS                     70.0          mi/h
                                         Rural Freeway

__________________________LOS and Performance Measures___________________________

Flow rate, vp                            1016          pc/h/ln
Free-flow speed, FFS                     70.0          mi/h
Average passenger-car speed, S           70.0          mi/h
Number of lanes, N                       2
Density, D                               14.5          pc/mi/ln
Level of service, LOS                    B

  Overall results are not computed when free-flow speed is less than 55 mph.
```

2008 Wellsville North Existing - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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E-mail:

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__________________________Operational Analysis___________________________________

Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         3/18/2008 10:15:14 AM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Southbound
From/To:                151Street to US 56
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________Flow Inputs and Adjustments____________________________

Volume, V                               2910          veh/h
Peak-hour factor, PHF                   0.90
Peak 15-min volume, v15                 808           v
Trucks and buses                        7             %
Recreational vehicles                   0             %
Terrain type:                           Level
    Grade                               0.00          %
    Segment length                      0.00          mi
Trucks and buses PCE, ET                1.5
Recreational vehicle PCE, ER            1.2
Heavy vehicle adjustment, fHV           0.966
Driver population factor, fp            1.00
Flow rate, vp                           1673          pc/h/ln

__________________________Speed Inputs and Adjustments___________________________

Lane width                              12.0          ft
Right-shoulder lateral clearance        6.0           ft
Interchange density                     0.50          interchange/mi
Number of lanes, N                      2
Free-flow speed:                        Measured
     FFS or BFFS                        70.0          mi/h
Lane width adjustment, fLW              0.0           mi/h
Lateral clearance adjustment, fLC       0.0           mi/h
Interchange density adjustment, fID     0.0           mi/h
Number of lanes adjustment, fN          0.0           mi/h
Free-flow speed, FFS                    70.0          mi/h
                                        Rural Freeway

__________________________LOS and Performance Measures___________________________

Flow rate, vp                           1673          pc/h/ln
Free-flow speed, FFS                    70.0          mi/h
Average passenger-car speed, S          69.0          mi/h
Number of lanes, N                      2
Density, D                              24.2          pc/mi/ln
Level of service, LOS                   C

  Overall results are not computed when free-flow speed is less than 55 mph.
```

HCS+: Basic Freeway Segments Release 5.21

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__________________________Operational Analysis___________________________________

Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         3/18/2008 10:15:14 AM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Southbound
From/To:                Gardner Road to Sunflower Road
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________Flow Inputs and Adjustments____________________________

Volume, V                               1530          veh/h
Peak-hour factor, PHF                   0.90
Peak 15-min volume, v15                 425           v
Trucks and buses                        11            %
Recreational vehicles                   0             %
Terrain type:                           Level
    Grade                               0.00          %
    Segment length                      0.00          mi
Trucks and buses PCE, ET                1.5
Recreational vehicle PCE, ER            1.2
Heavy vehicle adjustment, fHV           0.948
Driver population factor, fp            1.00
Flow rate, vp                           897           pc/h/ln

__________________________Speed Inputs and Adjustments___________________________

Lane width                              12.0          ft
Right-shoulder lateral clearance        6.0           ft
Interchange density                     0.50          interchange/mi
Number of lanes, N                      2
Free-flow speed:                        Measured
     FFS or BFFS                        70.0          mi/h
Lane width adjustment, fLW              0.0           mi/h
Lateral clearance adjustment, fLC       0.0           mi/h
Interchange density adjustment, fID     0.0           mi/h
Number of lanes adjustment, fN          0.0           mi/h
Free-flow speed, FFS                    70.0          mi/h
                                        Rural Freeway

__________________________LOS and Performance Measures___________________________

Flow rate, vp                           897           pc/h/ln
Free-flow speed, FFS                    70.0          mi/h
Average passenger-car speed, S          70.0          mi/h
Number of lanes, N                      2
Density, D                              12.8          pc/mi/ln
Level of service, LOS                   B

  Overall results are not computed when free-flow speed is less than 55 mph.
```

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Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/18/2008 10:15:14 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	Sunflower Road to Edgerton Road
Jurisdiction:	
Analysis Year:	2008

Description: NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	1320	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	367	v
Trucks and buses	12	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.943	
Driver population factor, fp	1.00	
Flow rate, vp	777	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	777	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	11.1	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

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E-mail:

Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/18/2008 10:15:14 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	US 56 to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2008

Description: NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	1950	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	542	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1132	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	1132	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	16.2	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

```
                      HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                     Fax:
E-mail:

_________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 11:10:33 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         1130           vph

_________________________________Off Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0           mph
Volume on ramp                            11             vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1130        11                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 314         3                    v
Trucks and buses                        9           9                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.957       0.881
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1312        14                         pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1312   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                            Actual        Maximum        LOS F?
     v  = v                 1312          4800           No
      Fi   F
     v  = v - v             1298          4800           No
      FO   F   R
     v                      14            2000           No
      R
     v     v                0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?            No
      3 or  av34
Is   v     v      > 1.5 v  /2             No
      3 or  av34         12
If yes, v    =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                       Actual        Max Desirable          Violation?
     v                 1312          4600                   No
      12                                                                        !
_________________Level of Service Determination (if not F)____________________

Density,            D = 4.252 + 0.0086 v  - 0.009  L   =   8.3     pc/mi/ln
                     R                  12          D
Level of service for ramp-freeway junction areas of influence A

_______________________________Speed Estimation________________________________

Intermediate speed variable,                 D  = 0.429
                                              S
Space mean speed in ramp influence area,     S  = 58.0    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 58.0    mph
_______________________________________________________________________________
```

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                      HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                     Fax:
E-mail:

_________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 11:10:33 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         1119           vph

__________________________________On Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0           mph
Volume on ramp                            238            vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1119        238                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 311         66                   v
Trucks and buses                        9           2                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

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Heavy vehicle adjustment, fHV           0.957       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1299        272                        pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1299   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                            Actual        Maximum        LOS F?
     v                      1571          4800           No
      FO
     v     v                0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?            No
      3 or  av34
Is   v     v      > 1.5 v  /2             No
      3 or  av34         12
If yes, v    =                            (Equation 25-8)
         12A

_________________________Flow Entering Merge Influence Area____________________
                       Actual        Max Desirable          Violation?
     v                 1299          4400                   No
      12                                                                        !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   12.6    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

_______________________________Speed Estimation________________________________

Intermediate speed variable,                 M  = 0.284
                                              S
Space mean speed in ramp influence area,     S  = 62.1    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.1    mph
_______________________________________________________________________________
```

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Phone:                                     Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1360           vph

_________________________________Off Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0           mph
Volume on ramp                             86             vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1360        86                    vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                378         24                    v
Trucks and buses                       8           2                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
    Grade                              0.00    %   0.00    %             %
    Length                             0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.962       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1572        98                       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1572   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                          Actual        Maximum         LOS F?
     v  = v               1572          4800            No
      Fi   F
     v  = v - v           1474          4800            No
      FO   F   R
     v                    98            2000            No
      R
     v     v              0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?         No
      3 or  av34
Is   v     v       > 1.5 v  /2          No
      3 or  av34          12
If yes, v    =                          (Equation 25-18)
         12A

_______________________Flow Entering Diverge Influence Area____________________
                     Actual        Max Desirable         Violation?
     v               1572          4600                  No
      12                                                                    !
_________________Level of Service Determination (if not F)_____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   10.6    pc/mi/ln
                        R                 12         D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,               D  = 0.437
                                            S
Space mean speed in ramp influence area,   S  = 57.8    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 57.8    mph
_______________________________________________________________________________
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Phone:                                     Fax:
E-mail:

_________________________________Merge Analysis_________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1274           vph

__________________________________On Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             554            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1274        554                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                354         154                   v
Trucks and buses                       8           2                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
    Grade                                      %           %             %
    Length                                     mi          mi            mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.962       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1472        634                      pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1472   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                          Actual        Maximum         LOS F?
     v                    2106          4800            No
      FO
     v     v              0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?         No
      3 or  av34
Is   v     v       > 1.5 v  /2          No
      3 or  av34          12
If yes, v    =                          (Equation 25-8)
         12A

_________________________Flow Entering Merge Influence Area____________________
                     Actual        Max Desirable         Violation?
     v               1472          4400                  No
      12                                                                    !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   16.6    pc/mi/ln
                              R            12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,               M  = 0.297
                                            S
Space mean speed in ramp influence area,   S  = 61.7    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 61.7    mph
_______________________________________________________________________________
```

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Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         1830           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0           mph
Volume on ramp                            227            vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                  Freeway     Ramp        Adjacent
                                                             Ramp
Volume, V (vph)                      1830        227                  vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              508         63                   v
Trucks and buses                     6           7                    %
Recreational vehicles                0           0                    %
Terrain type:                        Level       Rolling
     Grade                           0.00    %   0.00    %            %
     Length                          0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
Heavy vehicle adjustment, fHV        0.971       0.905
Driver population factor, fP         1.00        1.00
Flow rate, vp                        2094        279                     pcph

_________________________Estimation of V12 Diverge Areas________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2094   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                2094          4800            No
      Fi   F
     v  = v - v            1815          4800            No
      FO   F   R
     v                     279           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                2094          4600                   No
      12                                                                       !
________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   15.1    pc/mi/ln
                        R              12       D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                 D  = 0.453
                                              S
Space mean speed in ramp influence area,     S  = 57.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.3    mph
________________________________________________________________________________
```

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Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 11:10:33 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         2946           vph

__________________________________On Ramp Data___________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0           mph
Volume on ramp                            118            vph
Length of first accel/decel lane          1000           ft
Length of second accel/decel lane                        ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                  Freeway     Ramp        Adjacent
                                                             Ramp
Volume, V (vph)                      2946        118                  vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              818         33                   v
Trucks and buses                     6           2                    %
Recreational vehicles                0           0                    %
Terrain type:                        Level       Rolling
     Grade                                   %           %            %
     Length                                  mi          mi           mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
Heavy vehicle adjustment, fHV        0.971       0.971
Driver population factor, fP         1.00        1.00
Flow rate, vp                        3372        135                     pcph

_________________________Estimation of V12 Merge Areas__________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  3372   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     3507          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-8)
         12A

_________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                3372          4400                   No
      12                                                                       !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   26.5    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                 M  = 0.381
                                              S
Space mean speed in ramp influence area,     S  = 59.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 59.3    mph
________________________________________________________________________________
```

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Phone:                                     Fax:
E-mail:

_________________________________Merge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1603           vph

__________________________________On Ramp Data______________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             1343           vph
Length of first accel/decel lane           500            ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1603        1343                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                445         373                  v
Trucks and buses                       6           2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.971       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1835        1537                 pcph

_________________________Estimation of V12 Merge Areas__________________________

                  L  =              (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1835   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual         Maximum         LOS F?
     v                     3372           4800            No
      FO
     v     v               0    pc/h      (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?           No
      3 or  av34
Is   v     v       > 1.5 v  /2            No
      3 or  av34          12
If yes, v    =                            (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual         Max Desirable          Violation?
     v                1835           4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   27.9    pc/mi/ln
          R                    R            12            A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                  M  = 0.400
                                               S
Space mean speed in ramp influence area,      S  = 58.8    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 58.8    mph
_______________________________________________________________________________
```

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Phone:                                     Fax:
E-mail:

_________________________________Diverge Analysis____________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               8 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1400           vph

_________________________________Off Ramp Data______________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    45.0           mph
Volume on ramp                             924            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1400        924                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                389         257                  v
Trucks and buses                       9           3                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.957       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1626        1073                 pcph

_________________________Estimation of V12 Diverge Areas________________________

                  L  =              (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1626   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual         Maximum         LOS F?
     v  = v                1626           4800            No
      Fi   F
     v  = v - v            553            4800            No
      FO   F   R
     v                     1073           2100            No
      R
     v     v               0    pc/h      (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?           No
      3 or  av34
Is   v     v       > 1.5 v  /2            No
      3 or  av34          12
If yes, v    =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual         Max Desirable          Violation?
     v                1626           4600                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density,                D = 4.252 + 0.0086 v  - 0.009  L   =    11.0    pc/mi/ln
                                           R           12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                  D  = 0.395
                                               S
Space mean speed in ramp influence area,      S  = 59.0    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 59.0    mph
_______________________________________________________________________________
```

2008 Wellsville North Existing - AM Peak Hour - HCS Freeway Ramps

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Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               9 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         476            vph

__________________________________On Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0           mph
Volume on ramp                            63             vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       476         63                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               132         18                   v
Trucks and buses                      9           16                   %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                                    %           %            %
     Length                                   mi          mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
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Heavy vehicle adjustment, fHV         0.957       0.806
Driver population factor, fP          1.00        1.00
Flow rate, vp                         553         87                    pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  553    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     640           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v         > 2700 pc/h?        No
      3 or  av34
Is   v     v         > 1.5 v  /2         No
      3 or  av34            12
If yes, v     =                          (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                553           4400                  No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   5.4     pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  A

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.272
                                              S
Space mean speed in ramp influence area,     S  = 62.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.4    mph
_______________________________________________________________________________
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Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         540            vph

_________________________________Off Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0           mph
Volume on ramp                            94             vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       540         94                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               150         26                   v
Trucks and buses                      19          13                   %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %            %
     Length                           0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.913       0.837
Driver population factor, fP          1.00        1.00
Flow rate, vp                         657         125                   pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  657    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                657           4800            No
      Fi   F
     v  = v - v            532           4800            No
      FO   F   R
     v                     125           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v         > 2700 pc/h?        No
      3 or  av34
Is   v     v         > 1.5 v  /2         No
      3 or  av34            12
If yes, v     =                          (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                657           4600                  No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =    2.7     pc/mi/ln
                                        R            12          D
Level of service for ramp-freeway junction areas of influence A

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.439
                                              S
Space mean speed in ramp influence area,     S  = 57.7    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.7    mph
_______________________________________________________________________________
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Phone:                                  Fax:
E-mail:

_______________________________Merge Analysis_______________________________

Analyst:               Tom Hiles
Agency/Co.:            HDR Inc.
Date performed:        3/27/2008 11:10:33 AM
Analysis time period:  AM
Freeway/Dir of Travel: I-35 Southbound
Junction:              11 Gardner Entr
Jurisdiction:          KDOT
Analysis Year:         2008
Description:  NEPA Traffic Study

________________________________Freeway Data________________________________

Type of analysis                         Merge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0          mph
Volume on freeway                        445           vph

________________________________On Ramp Data________________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-flow speed on ramp                  35.0          mph
Volume on ramp                           50            vph
Length of first accel/decel lane         800           ft
Length of second accel/decel lane                      ft

_______________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                No
Volume on adjacent Ramp                                vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                              ft

__________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway    Ramp       Adjacent
                                                            Ramp
Volume, V (vph)                       445        50                  vph
Peak-hour factor, PHF                 0.90       0.90
Peak 15-min volume, v15               124        14                  v
Trucks and buses                      19         4                   %
Recreational vehicles                 0          0                   %
Terrain type:                         Level      Rolling
    Grade                                    %          %          %
    Length                                   mi         mi         mi
Trucks and buses PCE, ET              1.5*       2.5
Recreational vehicle PCE, ER          1.2*       2.0
```

```
Heavy vehicle adjustment, fHV         0.913      0.943
Driver population factor, fP          1.00       1.00
Flow rate, vp                         541        59                  pcph

________________________Estimation of V12 Merge Areas_______________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  541    pc/h
                   12   F   FM

______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
    v                      600           4800            No
     FO
    v     v                0    pc/h     (Equation 25-4 or 25-5)
     3 or  av34
Is   v     v         > 2700 pc/h?        No
     3 or  av34
Is   v     v         > 1.5 v  /2         No
     3 or  av34             12
If yes, v    =                           (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable         Violation?
    v                 541           4400                  No
     12                                                                   !
________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   5.1     pc/mi/ln
          R                   R            12             A
Level of service for ramp-freeway junction areas of influence  A

____________________________Speed Estimation________________________________

Intermediate speed variable,                M  = 0.272
                                             S
Space mean speed in ramp influence area,    S  = 62.4    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 62.4    mph
_____________________________________________________________________________
```

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E-mail:

______________________________Diverge Analysis______________________________

Analyst:               Tom Hiles
Agency/Co.:            HDR Inc.
Date performed:        3/27/2008 11:10:33 AM
Analysis time period:  AM
Freeway/Dir of Travel: I-35 Southbound
Junction:              12 Sunflower Exit
Jurisdiction:          KDOT
Analysis Year:         2008
Description:  NEPA Traffic Study

________________________________Freeway Data________________________________

Type of analysis                         Diverge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0          mph
Volume on freeway                        500           vph

_______________________________Off Ramp Data________________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-Flow speed on ramp                  35.0          mph
Volume on ramp                           35            vph
Length of first accel/decel lane         800           ft
Length of second accel/decel lane                      ft

_______________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                No
Volume on adjacent ramp                                vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                              ft

__________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway    Ramp       Adjacent
                                                            Ramp
Volume, V (vph)                       500        35                  vph
Peak-hour factor, PHF                 0.90       0.90
Peak 15-min volume, v15               139        10                  v
Trucks and buses                      18         6                   %
Recreational vehicles                 0          0                   %
Terrain type:                         Level      Rolling
    Grade                             0.00   %   0.00   %          %
    Length                            0.00   mi  0.00   mi         mi
Trucks and buses PCE, ET              1.5*       2.5
Recreational vehicle PCE, ER          1.2*       2.0
```

```
Heavy vehicle adjustment, fHV         0.917      0.917
Driver population factor, fP          1.00       1.00
Flow rate, vp                         606        42                  pcph

________________________Estimation of V12 Diverge Areas_____________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  606    pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
    v  = v                 606           4800            No
     Fi   F
    v  = v - v             564           4800            No
     FO   F   R
    v                      42            2000            No
     R
    v     v                0    pc/h     (Equation 25-15 or 25-16)
     3 or  av34
Is   v     v         > 2700 pc/h?        No
     3 or  av34
Is   v     v         > 1.5 v  /2         No
     3 or  av34             12
If yes, v    =                           (Equation 25-18)
         12A

_____________________Flow Entering Diverge Influence Area__________________
                      Actual        Max Desirable         Violation?
    v                 606           4600                  No
     12                                                                   !
________________Level of Service Determination (if not F)___________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   2.3     pc/mi/ln
                      R                  12           D
Level of service for ramp-freeway junction areas of influence A

____________________________Speed Estimation________________________________

Intermediate speed variable,                D  = 0.432
                                             S
Space mean speed in ramp influence area,    S  = 57.9    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.9    mph
_____________________________________________________________________________
```

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Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Trishul Palekar
Agency/Co.:	HDR Inc.
Date performed:	3/18/2008 11:13:41 AM
Analysis time period:	AM
Freeway/Dir of Travel:	I-35 Southbound
Junction:	13 Sunflower Entr
Jurisdiction:	KDOT
Analysis Year:	2008

Description: NEPA Traffic Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	465	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	4	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	465	4		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	129	1		v
Trucks and buses	18	0		%
Recreational vehicles	0	0		%
Terrain type:	Level	Rolling		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5*	2.5		
Recreational vehicle PCE, ER	1.2*	2.0		
Heavy vehicle adjustment, fHV	0.917	1.000		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	563	4		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 563 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	567	4800	No
v_{3} or v_{av34}	0 pc/h	(Equation 25-4 or 25-5)	
Is v_{3} or v_{av34} > 2700 pc/h?		No	
Is v_{3} or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} =		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	563	4400	No

!

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 4.9 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable,	M_S = 0.272	
Space mean speed in ramp influence area,	S_R = 62.4	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 62.4	mph

```
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E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 11:10:33 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          650           vph

________________________________Off Ramp Data_________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0          mph
Volume on ramp                             5             vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        650         5                    vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                181                              v
Trucks and buses                       20          0                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.909       1.000
Driver population factor, fP           1.00        1.00
Flow rate, vp                          794         6                       pcph

________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  794    pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_________________________________

                           Actual        Maximum        LOS F?
     v  = v                794           4800           No
      Fi   F
     v  = v - v            788           4800           No
      FO   F   R
     v                     6             2000           No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-18)
         12A

_____________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                794           4600                   No
      12                                                                   !
________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   3.9     pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence A

______________________________Speed Estimation________________________________

Intermediate speed variable,                  D  = 0.429
                                               S
Space mean speed in ramp influence area,      S  = 58.0    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 58.0    mph
______________________________________________________________________________
```

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E-mail:

________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 11:10:33 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          645           vph

_________________________________On Ramp Data_________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0          mph
Volume on ramp                             87            vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        645         87                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                179         24                   v
Trucks and buses                       20          5                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.909       0.930
Driver population factor, fP           1.00        1.00
Flow rate, vp                          788         104                     pcph

________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  788    pc/h
                   12   F   FM

______________________________Capacity Checks_________________________________

                           Actual        Maximum        LOS F?
     v                     892           4800           No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                788           4400                   No
      12                                                                   !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   7.4     pc/mi/ln
          R                   R          12             A
Level of service for ramp-freeway junction areas of influence  A

______________________________Speed Estimation________________________________

Intermediate speed variable,                  M  = 0.275
                                               S
Space mean speed in ramp influence area,      S  = 62.3    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 62.3    mph
______________________________________________________________________________
```

2008 Wellsville North Existing - PM Peak Hour - HCS Freeway Ramps

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                     HCS+: Ramps and Ramp Junctions Release 5.21


Phone:                                       Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          3/18/2008 11:13:41 AM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                3 Gardner Exit
Jurisdiction:            KDOT
Analysis Year:           2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           730            vph

_________________________________Off Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              55             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         730         55                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 203         15                   v
Trucks and buses                        18          7                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.917       0.905
Driver population factor, fP            1.00        1.00
Flow rate, vp                           884         68                         pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  884    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                884           4800            No
      Fi   F
     v  = v - v            816           4800            No
      FO   F   R
     v                     68            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                884           4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,           D = 4.252 + 0.0086 v  - 0.009  L   =   4.7     pc/mi/ln
                                     R           12      D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.434
                                              S
Space mean speed in ramp influence area,     S  = 57.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.8    mph
_______________________________________________________________________________
```

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                     HCS+: Ramps and Ramp Junctions Release 5.21


Phone:                                       Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          3/18/2008 11:13:41 AM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                4 Gardner Entr
Jurisdiction:            KDOT
Analysis Year:           2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           675            vph

__________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              239            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         675         239                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 188         66                   v
Trucks and buses                        18          6                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.917       0.917
Driver population factor, fP            1.00        1.00
Flow rate, vp                           818         289                        pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  818    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1107          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                818           4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   9.0     pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.277
                                              S
Space mean speed in ramp influence area,     S  = 62.2    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.2    mph
_______________________________________________________________________________
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Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0            mph
Volume on freeway                           920             vph

_________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0            mph
Volume on ramp                              107             vph
Length of first accel/decel lane            800             ft
Length of second accel/decel lane                           ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                     vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                   ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         920         107                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 256         30                   v
Trucks and buses                        16          9                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.926       0.881
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1104        135                  pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1104   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                1104          4800            No
      Fi   F
     v  = v - v            969           4800            No
      FO   F   R
     v                     135           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1104          4600                   No
      12                                                                      !
________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   6.5     pc/mi/ln
                          R                  12        D
Level of service for ramp-freeway junction areas of influence A

______________________________Speed Estimation__________________________________

Intermediate speed variable,                D  = 0.440
                                             S
Space mean speed in ramp influence area,    S  = 57.7    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.7    mph
________________________________________________________________________________
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_________________________________Merge Analysis__________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0            mph
Volume on freeway                           1732            vph

__________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0            mph
Volume on ramp                              18              vph
Length of first accel/decel lane            1000            ft
Length of second accel/decel lane                           ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                     vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                   ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1732        18                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 481         5                    v
Trucks and buses                        16          3                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.926       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2078        21                   pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2078   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     2099          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2078          4400                   No
      12                                                                      !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   15.6    pc/mi/ln
                             R            12            A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation__________________________________

Intermediate speed variable,                M  = 0.283
                                             S
Space mean speed in ramp influence area,    S  = 62.1    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 62.1    mph
________________________________________________________________________________
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E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                        Merge
Number of lanes in freeway              2
Free-flow speed on freeway              70.0           mph
Volume on freeway                       813            vph

__________________________________On Ramp Data_________________________________

Side of freeway                         Right
Number of lanes in ramp                 1
Free-flow speed on ramp                 35.0           mph
Volume on ramp                          924            vph
Length of first accel/decel lane        500            ft
Length of second accel/decel lane                      ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?               No
Volume on adjacent Ramp                                vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                              ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                 Freeway     Ramp        Adjacent
                                                            Ramp
Volume, V (vph)                     813         924                  vph
Peak-hour factor, PHF               0.90        0.90
Peak 15-min volume, v15             226         257                  v
Trucks and buses                    16          3                    %
Recreational vehicles               0           0                    %
Terrain type:                       Level       Rolling
     Grade                                  %           %           %
     Length                                 mi          mi          mi
Trucks and buses PCE, ET            1.5*        2.5
Recreational vehicle PCE, ER        1.2*        2.0
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Heavy vehicle adjustment, fHV           0.926       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           976         1073                    pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  976    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2049          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v         > 2700 pc/h?        No
      3 or  av34
Is   v     v         > 1.5 v  /2         No
      3 or  av34            12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                976           4400                  No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   17.8    pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.316
                                              S
Space mean speed in ramp influence area,     S  = 61.1    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.1    mph
_______________________________________________________________________________
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E-mail:

_________________________________Diverge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/18/2008 11:13:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               8 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                        Diverge
Number of lanes in freeway              2
Free-flow speed on freeway              70.0           mph
Volume on freeway                       2910           vph

_________________________________Off Ramp Data_________________________________

Side of freeway                         Right
Number of lanes in ramp                 1
Free-Flow speed on ramp                 45.0           mph
Volume on ramp                          1250           vph
Length of first accel/decel lane        800            ft
Length of second accel/decel lane                      ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?               No
Volume on adjacent ramp                                vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                              ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                 Freeway     Ramp        Adjacent
                                                            Ramp
Volume, V (vph)                     2910        1250                 vph
Peak-hour factor, PHF               0.90        0.90
Peak 15-min volume, v15             808         347                  v
Trucks and buses                    7           2                    %
Recreational vehicles               0           0                    %
Terrain type:                       Level       Rolling
     Grade                          0.00    %   0.00    %           %
     Length                         0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET            1.5*        2.5
Recreational vehicle PCE, ER        1.2*        2.0
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Heavy vehicle adjustment, fHV           0.966       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3346        1431                    pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  3346   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                3346          4800            No
      Fi   F
     v  = v - v            1915          4800            No
      FO   F   R
     v                     1431          2100            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v         > 2700 pc/h?        No
      3 or  av34
Is   v     v         > 1.5 v  /2         No
      3 or  av34            12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                3346          4600                  No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   25.8    pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.427
                                              S
Space mean speed in ramp influence area,     S  = 58.0    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 58.0    mph
_______________________________________________________________________________
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E-mail:

_________________________________Merge Analysis______________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          3/18/2008 11:13:41 AM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Southbound
Junction:                9 US 56 Entr
Jurisdiction:            KDOT
Analysis Year:           2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1660          vph

__________________________________On Ramp Data______________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              292           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1660        292                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 461         81                   v
Trucks and buses                        7           3                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                     %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.966       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1909        339                     pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1909   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                             Actual        Maximum         LOS F?
     v                       2248          4800            No
      FO
     v     v                 0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?           No
      3 or  av34
Is   v     v        > 1.5 v  /2            No
      3 or  av34           12
If yes, v    =                             (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                        Actual        Max Desirable          Violation?
     v                  1909          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   17.8    pc/mi/ln
          R                   R            12             A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                  M  = 0.302
                                               S
Space mean speed in ramp influence area,      S  = 61.5    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 61.5    mph
_______________________________________________________________________________
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_________________________________Diverge Analysis____________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          3/18/2008 11:13:41 AM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Southbound
Junction:                10 Gardner Exit
Jurisdiction:            KDOT
Analysis Year:           2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1950          vph

_________________________________Off Ramp Data______________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              508           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1950        508                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 542         141                  v
Trucks and buses                        9           5                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00   %    0.00   %           %
     Length                             0.00   mi   0.00   mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.957       0.930
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2264        607                     pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2264   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                             Actual        Maximum         LOS F?
     v  = v                  2264          4800            No
      Fi   F
     v  = v - v              1657          4800            No
      FO   F   R
     v                       607           2000            No
      R
     v     v                 0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?           No
      3 or  av34
Is   v     v        > 1.5 v  /2            No
      3 or  av34           12
If yes, v    =                             (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                        Actual        Max Desirable          Violation?
     v                  2264          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,                D = 4.252 + 0.0086 v  - 0.009  L   =   16.5    pc/mi/ln
                                            R          12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                  D  = 0.483
                                               S
Space mean speed in ramp influence area,      S  = 56.5    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 56.5    mph
_______________________________________________________________________________
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________________________________Merge Analysis_________________________________

Analyst:               Trishul Palekar
Agency/Co.:            HDR Inc.
Date performed:        3/18/2008 11:13:41 AM
Analysis time period:  PM
Freeway/Dir of Travel: I-35 Southbound
Junction:              11 Gardner Entr
Jurisdiction:          KDOT
Analysis Year:         2008
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                        Merge
Number of lanes in freeway              2
Free-flow speed on freeway              70.0          mph
Volume on freeway                       1442          vph

_________________________________On Ramp Data__________________________________

Side of freeway                         Right
Number of lanes in ramp                 1
Free-flow speed on ramp                 35.0          mph
Volume on ramp                          87            vph
Length of first accel/decel lane        800           ft
Length of second accel/decel lane                     ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?               No
Volume on adjacent Ramp                               vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                             ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                 Freeway    Ramp        Adjacent
                                                           Ramp
Volume, V (vph)                     1442       87                   vph
Peak-hour factor, PHF               0.90       0.90
Peak 15-min volume, v15             401        24                   v
Trucks and buses                    9          6                    %
Recreational vehicles               0          0                    %
Terrain type:                       Level      Rolling
     Grade                                %          %          %
     Length                               mi         mi         mi
Trucks and buses PCE, ET            1.5*       2.5
Recreational vehicle PCE, ER        1.2*       2.0
Heavy vehicle adjustment, fHV       0.957      0.917
Driver population factor, fP        1.00       1.00
Flow rate, vp                       1674       105                  pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1674   pc/h
                   12   F   FM

________________________________Capacity Checks________________________________

                          Actual        Maximum         LOS F?
     v                    1779          4800            No
      FO
     v     v              0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?        No
      3 or  av34
Is   v     v        > 1.5 v  /2         No
      3 or  av34           12
If yes, v    =                          (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                     Actual        Max Desirable         Violation?
     v               1674          4400                  No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   14.3    pc/mi/ln
          R                   R          12             A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation_________________________________

Intermediate speed variable,                M  = 0.288
                                             S
Space mean speed in ramp influence area,    S  = 61.9    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 61.9    mph
_______________________________________________________________________________
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Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:               Tom Hiles
Agency/Co.:            HDR Inc.
Date performed:        3/27/2008 11:10:33 AM
Analysis time period:  PM
Freeway/Dir of Travel: I-35 Southbound
Junction:              12 Sunflower Exit
Jurisdiction:          KDOT
Analysis Year:         2008
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                        Diverge
Number of lanes in freeway              2
Free-flow speed on freeway              70.0          mph
Volume on freeway                       1530          vph

________________________________Off Ramp Data__________________________________

Side of freeway                         Right
Number of lanes in ramp                 1
Free-Flow speed on ramp                 35.0          mph
Volume on ramp                          236           vph
Length of first accel/decel lane        800           ft
Length of second accel/decel lane                     ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?               No
Volume on adjacent ramp                               vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                             ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                 Freeway    Ramp        Adjacent
                                                           Ramp
Volume, V (vph)                     1530       236                  vph
Peak-hour factor, PHF               0.90       0.90
Peak 15-min volume, v15             425        66                   v
Trucks and buses                    11         2                    %
Recreational vehicles               0          0                    %
Terrain type:                       Level      Rolling
     Grade                          0.00    %  0.00    %            %
     Length                         0.00    mi 0.00    mi           mi
Trucks and buses PCE, ET            1.5*       2.5
Recreational vehicle PCE, ER        1.2*       2.0
Heavy vehicle adjustment, fHV       0.948      0.971
Driver population factor, fP        1.00       1.00
Flow rate, vp                       1794       270                  pcph

________________________Estimation of V12 Diverge Areas________________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1794   pc/h
                   12   R     F   R   FD

________________________________Capacity Checks________________________________

                          Actual        Maximum         LOS F?
     v  = v               1794          4800            No
      Fi   F
     v  = v - v           1524          4800            No
      FO   F   R
     v                    270           2000            No
      R
     v     v              0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?        No
      3 or  av34
Is   v     v        > 1.5 v  /2         No
      3 or  av34           12
If yes, v    =                          (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                     Actual        Max Desirable         Violation?
     v               1794          4600                  No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   12.5    pc/mi/ln
                                          R          12          D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation_________________________________

Intermediate speed variable,                D  = 0.452
                                             S
Space mean speed in ramp influence area,    S  = 57.3    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.3    mph
_______________________________________________________________________________
```

```
                HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 11:10:33 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2008
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         1294           vph

__________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0           mph
Volume on ramp                            25             vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1294        25                    vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               359         7                     v
Trucks and buses                      11          8                     %
Recreational vehicles                 0           0                     %
Terrain type:                         Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.948       0.893
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1517        31                     pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1517   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1548          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1517          4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   12.5    pc/mi/ln
          R                   R          12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                  M  = 0.283
                                               S
Space mean speed in ramp influence area,      S  = 62.1    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 62.1    mph
_______________________________________________________________________________
```

Appendix E:
Results of Operational Analysis
Gardner No Action, Proposed Action, and
Future Gardner IMF Operations

Synchro Analysis

1. 2010 Gardner No Action
2. 2010 Gardner Proposed Action
3. 2015 Gardner No Action
4. 2015 Gardner IMF Operations
5. 2030 Gardner No Action
6. 2030 Gardner IMF Operations

HCS Analysis

1. 2010 Gardner No Action
2. 2010 Gardner Proposed Action
3. 2015 Gardner No Action
4. 2015 Gardner IMF Operations
5. 2030 Gardner No Action
6. 2030 Gardner IMF Operations

2010 Gardner No Action - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 No-Action Gardner

1: 175th Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	60	290	5	0	50	50	5	80	5	90	20	10
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	72	349	6	0	60	60	6	96	6	108	24	12
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	120			355			611	617	352	642	590	90
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	120			355			611	617	352	642	590	90
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.6	6.3
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.4
p0 queue free %	95			100			98	75	99	63	94	99
cM capacity (veh/h)	1449			1214			370	384	696	296	395	946

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	428	120	108	145
Volume Left	72	0	6	108
Volume Right	6	60	6	12
cSH	1449	1214	393	329
Volume to Capacity	0.05	0.00	0.28	0.44
Queue Length 95th (ft)	4	0	28	54
Control Delay (s)	1.7	0.0	17.6	24.3
Lane LOS	A		C	C
Approach Delay (s)	1.7	0.0	17.6	24.3
Approach LOS			C	C

Intersection Summary			
Average Delay	7.7		
Intersection Capacity Utilization	45.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Gardner

2: US 56 & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	550	60	100	210	100	70	320	190	140	200	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.99			0.96		1.00	0.94		1.00	0.99	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3393			3188		1805	1725		1736	1808	
Flt Permitted		0.89			0.63		0.60	1.00		0.25	1.00	
Satd. Flow (perm)		3043			2020		1144	1725		460	1808	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	46	632	69	115	241	115	80	368	218	161	230	23
RTOR Reduction (vph)	0	16	0	0	64	0	0	31	0	0	5	0
Lane Group Flow (vph)	0	731	0	0	407	0	80	555	0	161	248	0
Heavy Vehicles (%)	3%	5%	2%	7%	9%	6%	0%	4%	4%	4%	4%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		17.7			17.7		19.4	19.4		19.4	19.4	
Effective Green, g (s)		17.7			17.7		19.4	19.4		19.4	19.4	
Actuated g/C Ratio		0.36			0.36		0.40	0.40		0.40	0.40	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1104			733		455	686		183	719	
v/s Ratio Prot								0.32			0.14	
v/s Ratio Perm		c0.24			0.20		0.07			c0.35		
v/c Ratio		0.66			0.55		0.18	0.81		0.88	0.34	
Uniform Delay, d1		13.0			12.4		9.5	13.1		13.6	10.3	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.5			0.9		0.2	7.0		34.7	0.3	
Delay (s)		14.5			13.3		9.7	20.0		48.3	10.5	
Level of Service		B			B		A	C		D	B	
Approach Delay (s)		14.5			13.3			18.8			25.2	
Approach LOS		B			B			B			C	

Intersection Summary			
HCM Average Control Delay	17.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	48.8	Sum of lost time (s)	11.7
Intersection Capacity Utilization	86.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 No-Action Gardner

3: US 56 & Elm

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	870	10	10	380	40	10	5	20	70	5	20
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			0.99			0.92			0.97	
Flt Protected		1.00			1.00			0.99			0.96	
Satd. Flow (prot)		3615			3467			1817			1853	
Flt Permitted		0.94			0.93			0.91			0.76	
Satd. Flow (perm)		3407			3238			1677			1458	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	22	935	11	11	409	43	11	5	22	75	5	22
RTOR Reduction (vph)	0	1	0	0	7	0	0	19	0	0	19	0
Lane Group Flow (vph)	0	967	0	0	456	0	0	19	0	0	83	0
Heavy Vehicles (%)	0%	5%	0%	0%	9%	0%	0%	0%	0%	0%	0%	5%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		30.9			30.9			6.1			6.1	
Effective Green, g (s)		30.9			30.9			6.1			6.1	
Actuated g/C Ratio		0.67			0.67			0.13			0.13	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2289			2175			222			193	
v/s Ratio Prot												
v/s Ratio Perm		c0.28			0.14			0.01			c0.06	
v/c Ratio		0.42			0.21			0.09			0.43	
Uniform Delay, d1		3.5			2.9			17.5			18.3	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.1			0.0			0.2			1.5	
Delay (s)		3.6			2.9			17.7			19.9	
Level of Service		A			A			B			B	
Approach Delay (s)		3.6			2.9			17.7			19.9	
Approach LOS		A			A			B			B	

Intersection Summary			
HCM Average Control Delay	4.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	46.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	55.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 No-Action Gardner

4: US 56 & Mulberry

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	950	10	10	380	50	5	5	20	90	5	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			0.98			0.91			0.97	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3459			3287			1605			1737	
Flt Permitted		0.93			0.93			0.95			0.77	
Satd. Flow (perm)		3234			3062			1530			1378	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	32	1022	11	11	409	54	5	5	22	97	5	32
RTOR Reduction (vph)	0	1	0	0	14	0	0	18	0	0	24	0
Lane Group Flow (vph)	0	1064	0	0	460	0	0	14	0	0	110	0
Heavy Vehicles (%)	7%	4%	0%	0%	8%	8%	0%	20%	5%	2%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		33.0			33.0			8.0			8.0	
Effective Green, g (s)		33.0			33.0			8.0			8.0	
Actuated g/C Ratio		0.66			0.66			0.16			0.16	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2134			2021			245			220	
v/s Ratio Prot												
v/s Ratio Perm		c0.33			0.15			0.01			c0.08	
v/c Ratio		0.50			0.23			0.06			0.50	
Uniform Delay, d1		4.3			3.4			17.8			19.2	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.2			0.1			0.1			1.8	
Delay (s)		4.5			3.5			17.9			20.9	
Level of Service		A			A			B			C	
Approach Delay (s)		4.5			3.5			17.9			20.9	
Approach LOS		A			A			B			C	

Intersection Summary			
HCM Average Control Delay	5.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	50.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	69.6%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

2010 Gardner No Action - AM Peak Hour - Synchro Intersection LOS

5: US 56 & Moonlight Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	60	910	130	40	290	160	120	120	110	430	150	50
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1752	3619	1568	1752	3282	1583	1752	3505	1538	3400	3505	1553
Flt Permitted	0.53	1.00	1.00	0.15	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	985	3619	1568	285	3282	1583	1752	3505	1538	3400	3505	1553
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	66	1000	143	44	319	176	132	132	121	473	165	55
RTOR Reduction (vph)	0	0	91	0	0	115	0	0	106	0	0	46
Lane Group Flow (vph)	66	1000	52	44	319	61	132	132	15	473	165	9
Heavy Vehicles (%)	3%	5%	3%	3%	10%	2%	3%	3%	5%	3%	3%	4%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		Perm
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			4
Actuated Green, G (s)	31.9	27.1	27.1	29.5	25.9	25.9	8.4	9.1	9.1	12.2	12.9	12.9
Effective Green, g (s)	31.9	27.1	27.1	29.5	25.9	25.9	8.4	9.1	9.1	12.2	12.9	12.9
Actuated g/C Ratio	0.43	0.36	0.36	0.39	0.35	0.35	0.11	0.12	0.12	0.16	0.17	0.17
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	468	1308	567	183	1133	547	196	425	187	553	603	267
v/s Ratio Prot	0.01	c0.28		c0.01	0.10		0.08	0.04		c0.14	c0.05	
v/s Ratio Perm	0.05		0.03	0.08		0.04			0.01			0.01
v/c Ratio	0.14	0.76	0.09	0.24	0.28	0.11	0.67	0.31	0.08	0.86	0.27	0.04
Uniform Delay, d1	12.9	21.1	15.8	15.2	17.8	16.7	32.0	30.1	29.2	30.5	27.0	25.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.09	0.92	0.73	1.00	1.00	1.00
Incremental Delay, d2	0.1	4.3	0.3	0.2	0.6	0.4	7.0	0.2	0.1	11.9	0.1	0.0
Delay (s)	12.9	25.4	16.1	15.5	18.4	17.1	41.8	27.9	21.3	42.4	27.1	25.9
Level of Service	B	C	B	B	B	B	D	C	C	D	C	C
Approach Delay (s)		23.6			17.8			30.6			37.5	
Approach LOS		C			B			C			D	

Intersection Summary			
HCM Average Control Delay	26.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	16.5
Intersection Capacity Utilization	67.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

6: Old US 56 & US 56

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Volume (veh/h)	40	10	1240	210	10	470
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	41	10	1278	216	10	485
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1541	639			1278	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1541	639			1278	
tC, single (s)	6.9	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	60	98			98	
cM capacity (veh/h)	103	423			550	

Direction, Lane #	NW 1	NW 2	NE 1	NE 2	NE 3	SW 1	SW 2	SW 3
Volume Total	41	10	639	639	216	10	242	242
Volume Left	41	0	0	0	0	10	0	0
Volume Right	0	10	0	0	216	0	0	0
cSH	103	423	1700	1700	1700	550	1700	1700
Volume to Capacity	0.40	0.02	0.38	0.38	0.13	0.02	0.14	0.14
Queue Length 95th (ft)	41	2	0	0	0	1	0	0
Control Delay (s)	61.6	13.7	0.0	0.0	0.0	11.7	0.0	0.0
Lane LOS	F	B				B		
Approach Delay (s)	52.1		0.0			0.2		
Approach LOS	F							

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	42.6%	ICU Level of Service	A
Analysis Period (min)	15		

7: US-56 & Cedar Niles

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	1270	90	230	1100	60	80	20	450	40	10	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00		1.00	0.88	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85	1.00	0.88	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1805	3689	1615	3433	3689	1615		1827	2842	1752	1606	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.73	1.00	0.68	1.00	
Satd. Flow (perm)	1805	3689	1615	3433	3689	1615		1387	2842	1263	1606	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	45	1427	101	258	1236	67	90	22	506	45	11	45
RTOR Reduction (vph)	0	0	53	0	0	28	0	0	0	0	35	0
Lane Group Flow (vph)	45	1427	48	258	1236	39	0	112	506	45	21	0
Heavy Vehicles (%)	0%	3%	0%	2%	3%	0%	0%	0%	0%	3%	0%	5%
Turn Type	Prot		Perm	Prot		Perm	Perm		Perm	Perm		
Protected Phases	5	2		1	6			8			4	
Permitted Phases			2			6	8		8	4		
Actuated Green, G (s)	4.4	41.5	41.5	10.5	47.6	47.6		19.4	19.4	19.4	19.4	
Effective Green, g (s)	4.4	41.5	41.5	10.5	47.6	47.6		19.4	19.4	19.4	19.4	
Actuated g/C Ratio	0.05	0.48	0.48	0.12	0.55	0.55		0.22	0.22	0.22	0.22	
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0	
Lane Grp Cap (vph)	91	1760	770	414	2018	884		309	634	282	358	
v/s Ratio Prot	0.02	c0.39		c0.08	0.34						0.01	
v/s Ratio Perm			0.03			0.02		0.08	c0.18	0.04		
v/c Ratio	0.49	0.81	0.06	0.62	0.61	0.04		0.36	0.80	0.16	0.06	
Uniform Delay, d1	40.2	19.4	12.3	36.4	13.4	9.1		28.6	31.9	27.2	26.6	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	1.5	2.8	0.0	2.1	0.4	0.0		0.3	6.5	0.1	0.0	
Delay (s)	41.8	22.2	12.3	38.5	13.8	9.2		28.8	38.4	27.3	26.6	
Level of Service	D	C	B	D	B	A		C	D	C	C	
Approach Delay (s)		22.1			17.7			36.7			26.9	
Approach LOS		C			B			D			C	

Intersection Summary			
HCM Average Control Delay	22.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	87.0	Sum of lost time (s)	15.6
Intersection Capacity Utilization	71.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

8: US-56 & I-35 SB Ramps

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	1710	40	20	470	0	0	0	0	50	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	0	1800	42	21	495	0	0	0	0	53	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		986										
pX, platoon unblocked				0.65			0.65	0.65	0.65	0.65	0.65	
vC, conflicting volume	495			1842			2111	2358	921	1437	2379	247
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	495			1229			1639	2018	0	608	2050	247
tC, single (s)	4.1			4.3			7.5	6.5	6.9	7.7	6.5	7.0
tC, 2 stage (s)												
tF (s)	2.2			2.3			3.5	4.0	3.3	3.6	4.0	3.3
p0 queue free %	100			94			100	100	100	77	100	100
cM capacity (veh/h)	1079			340			42	36	713	226	35	750

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	SB 1	SB 2
Volume Total	1200	642	21	247	247	53	0
Volume Left	0	0	21	0	0	53	0
Volume Right	0	42	0	0	0	0	0
cSH	1700	1700	340	1700	1700	226	1700
Volume to Capacity	0.71	0.38	0.06	0.15	0.15	0.23	0.00
Queue Length 95th (ft)	0	0	5	0	0	22	0
Control Delay (s)	0.0	0.0	16.3	0.0	0.0	25.7	0.0
Lane LOS			C			D	A
Approach Delay (s)	0.0		0.7			25.7	
Approach LOS						D	

Intersection Summary			
Average Delay	0.7		
Intersection Capacity Utilization	58.5%	ICU Level of Service	B
Analysis Period (min)	15		

2010 Gardner No Action - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 No-Action Gardner
9: US-56 & I-35 NB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	350	0	0	350	130	150	0	90	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	0	398	0	0	398	148	170	0	102	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	545			398			869	943	199	773	869	472
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	545			398			869	943	199	773	869	472
tC, single (s)	4.1			4.1			7.7	6.5	7.0	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.6	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			28	100	87	100	100	100
cM capacity (veh/h)	1034			1172			236	265	803	255	292	544

Direction, Lane #	EB 1	EB 2	WB 1	NB 1
Volume Total	199	199	545	273
Volume Left	0	0	0	170
Volume Right	0	0	148	102
cSH	1700	1700	1700	321
Volume to Capacity	0.12	0.12	0.32	0.85
Queue Length 95th (ft)	0	0	0	188
Control Delay (s)	0.0	0.0	0.0	55.9
Lane LOS				F
Approach Delay (s)	0.0		0.0	55.9
Approach LOS				F

Intersection Summary			
Average Delay	12.5		
Intersection Capacity Utilization	91.3%	ICU Level of Service	F
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Gardner
10: Sante Fe & Moonlight Road — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	40	90	260	70	120	190
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.97		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1752	1583	3382		1770	3471
Flt Permitted	0.95	1.00	1.00		0.54	1.00
Satd. Flow (perm)	1752	1583	3382		1005	3471
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	43	97	280	75	129	204
RTOR Reduction (vph)	0	89	16	0	0	0
Lane Group Flow (vph)	43	8	339	0	129	204
Heavy Vehicles (%)	3%	2%	4%	1%	2%	4%
Turn Type		Perm			Perm	
Protected Phases	6		8			4
Permitted Phases		6			4	
Actuated Green, G (s)	6.4	6.4	58.6		58.6	58.6
Effective Green, g (s)	6.4	6.4	58.6		58.6	58.6
Actuated g/C Ratio	0.09	0.09	0.78		0.78	0.78
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	150	135	2642		785	2712
v/s Ratio Prot	c0.02		0.10			0.06
v/s Ratio Perm		0.01			c0.13	
v/c Ratio	0.29	0.06	0.13		0.16	0.08
Uniform Delay, d1	32.2	31.5	2.0		2.1	1.9
Progression Factor	1.00	1.00	1.00		0.62	0.51
Incremental Delay, d2	1.1	0.2	0.1		0.4	0.1
Delay (s)	33.2	31.7	2.1		1.7	1.0
Level of Service	C	C	A		A	A
Approach Delay (s)	32.2		2.1			1.3
Approach LOS	C		A			A

Intersection Summary			
HCM Average Control Delay	6.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.18		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	34.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 No-Action Gardner
11: Waverly Road & US 56 — AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	20	0	10	5	10	60	250	0	5	80	10
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	25	0	13	6	13	76	316	0	6	101	13
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	604	595	316	601	589	108	114			316		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	604	595	316	601	589	108	114			316		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.3	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.4	2.2			2.2		
p0 queue free %	100	94	100	97	98	99	95			99		
cM capacity (veh/h)	385	396	729	378	400	925	1469			1255		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	25	32	392	120
Volume Left	0	13	76	6
Volume Right	0	13	0	13
cSH	396	502	1469	1255
Volume to Capacity	0.06	0.06	0.05	0.01
Queue Length 95th (ft)	5	5	4	0
Control Delay (s)	14.7	12.7	1.9	0.5
Lane LOS	B	B	A	A
Approach Delay (s)	14.7	12.7	1.9	0.5
Approach LOS	B	B		

Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	37.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Gardner
12: 183rd Street & Four Corners Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	5	5	5	10	5	10	10	5	5	10	5
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	5	5	11	5	11	11	5	5	11	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	16	22	27	22
Volume Left (vph)	5	5	11	5
Volume Right (vph)	5	5	5	5
Hadj (s)	-0.13	-0.10	-0.04	-0.10
Departure Headway (s)	3.9	3.9	4.0	3.9
Degree Utilization, x	0.02	0.02	0.03	0.02
Capacity (veh/h)	907	902	887	907
Control Delay (s)	7.0	7.0	7.1	7.0
Approach Delay (s)	7.0	7.0	7.1	7.0
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.0		
HCM Level of Service	A		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Gardner No Action - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 No-Action Gardner
13: 183rd Street & US 56 — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	10	0	10	10	5	0	310	10	0	80	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	13	0	13	13	6	0	392	13	0	101	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	516	509	104	509	506	399	108			405		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	516	509	104	509	506	399	108			405		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	97	100	97	97	99	100			100		
cM capacity (veh/h)	459	470	956	468	472	655	1496			1165		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	19	32	405	108
Volume Left	6	13	0	0
Volume Right	0	6	13	6
cSH	466	498	1496	1165
Volume to Capacity	0.04	0.06	0.00	0.00
Queue Length 95th (ft)	3	5	0	0
Control Delay (s)	13.1	12.7	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	13.1	12.7	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	26.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Gardner
14: 183rd Street & Waverly Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	10	5	5	20	10	5	5	5	5	5	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	11	5	5	22	11	5	5	5	5	5	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	33			16			54	57	14	60	54	27
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	33			16			54	57	14	60	54	27
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			99	99	99	99	99	100
cM capacity (veh/h)	1592			1614			942	835	1072	929	838	1054

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	16	38	16	11
Volume Left	0	5	5	5
Volume Right	5	11	5	0
cSH	1592	1614	940	881
Volume to Capacity	0.00	0.00	0.02	0.01
Queue Length 95th (ft)	0	0	1	1
Control Delay (s)	0.0	1.1	8.9	9.1
Lane LOS		A	A	A
Approach Delay (s)	0.0	1.1	8.9	9.1
Approach LOS			A	A

Intersection Summary			
Average Delay	3.5		
Intersection Capacity Utilization	16.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Gardner
15: 183rd Street & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	40	10	80	110	20	90	20	410	40	30	340	20
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	45	11	90	124	22	101	22	461	45	34	382	22
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	848	1011	202	882	1000	253	404			506		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	848	1011	202	882	1000	253	404			506		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	77	95	89	38	90	87	98			97		
cM capacity (veh/h)	199	229	811	201	233	753	1165			1069		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	45	101	124	124	22	307	199	34	255	150
Volume Left	45	0	124	0	22	0	0	34	0	0
Volume Right	0	90	0	101	0	0	45	0	0	22
cSH	199	633	201	535	1165	1700	1700	1069	1700	1700
Volume to Capacity	0.23	0.16	0.62	0.23	0.02	0.18	0.12	0.03	0.15	0.09
Queue Length 95th (ft)	21	14	88	22	1	0	0	2	0	0
Control Delay (s)	28.3	11.8	48.0	13.7	8.2	0.0	0.0	8.5	0.0	0.0
Lane LOS	D	B	E	B	A			A		
Approach Delay (s)	16.9		30.9		0.3			0.7		
Approach LOS	C		D							

Intersection Summary			
Average Delay	7.8		
Intersection Capacity Utilization	38.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Gardner
16: Four Corners Road & US 56 — AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	10	0	10	5	10	310	0	5	90	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	7	7	13	0	13	7	13	408	0	7	118	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	579	566	408	582	566	118	118			408		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	579	566	408	582	566	118	118			408		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	98	100	97	99	99			99		
cM capacity (veh/h)	412	430	648	409	430	939	1482			1162		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	26	20	421	125
Volume Left	7	0	13	7
Volume Right	13	7	0	0
cSH	510	525	1482	1162
Volume to Capacity	0.05	0.04	0.01	0.01
Queue Length 95th (ft)	4	3	1	0
Control Delay (s)	12.4	12.1	0.3	0.5
Lane LOS	B	B	A	A
Approach Delay (s)	12.4	12.1	0.3	0.5
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.3		
Intersection Capacity Utilization	31.8%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Gardner No Action - AM Peak Hour - Synchro Intersection LOS

17: 191st Street & US 56

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	10	10	5	0	0	5	0	320	5	0	90	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	13	13	6	0	0	6	0	416	6	0	117	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	545	542	120	552	542	419	123			422		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	545	542	120	552	542	419	123			422		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	97	99	100	100	99	100			100		
cM capacity (veh/h)	447	450	937	435	450	639	1476			1148		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	32	6	422	123
Volume Left	13	0	0	0
Volume Right	6	6	6	6
cSH	501	639	1476	1148
Volume to Capacity	0.06	0.01	0.00	0.00
Queue Length 95th (ft)	5	1	0	0
Control Delay (s)	12.7	10.7	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	12.7	10.7	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	31.9%	ICU Level of Service	A
Analysis Period (min)	15		

18: 191st Street & Four Corners Road

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	5	10	10	10	10	10
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	11	11	11	11	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	49	16			22	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	49	16			22	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	99			99	
cM capacity (veh/h)	959	1069			1607	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	16	22	22
Volume Left	5	0	11
Volume Right	11	11	0
cSH	1029	1700	1607
Volume to Capacity	0.02	0.01	0.01
Queue Length 95th (ft)	1	0	1
Control Delay (s)	8.6	0.0	3.7
Lane LOS	A		A
Approach Delay (s)	8.6	0.0	3.7
Approach LOS	A		

Intersection Summary			
Average Delay	3.7		
Intersection Capacity Utilization	17.7%	ICU Level of Service	A
Analysis Period (min)	15		

19: 191st Street & Waverly Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	20	5	5	10	5	5	5	5	5	5	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	22	5	5	11	5	5	5	5	5	5	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	16			27			68	62	24	68	62	14
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	16			27			68	62	24	68	62	14
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			99	99	99	99	99	99
cM capacity (veh/h)	1614			1600			916	827	1058	915	827	1072

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	33	22	16	16
Volume Left	5	5	5	5
Volume Right	5	5	5	5
cSH	1614	1600	924	927
Volume to Capacity	0.00	0.00	0.02	0.02
Queue Length 95th (ft)	0	0	1	1
Control Delay (s)	1.2	1.8	9.0	9.0
Lane LOS	A	A	A	A
Approach Delay (s)	1.2	1.8	9.0	9.0
Approach LOS			A	A

Intersection Summary			
Average Delay	4.3		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

20: W 191st Street & Gardner Rd

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	5	5	20	10	5	10	10	240	5	5	480	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	2.5	2.5	2.5		2.5			2.5			2.5	2.5
Lane Util. Factor	1.00	1.00	1.00		1.00			0.95			0.95	1.00
Frt	1.00	1.00	0.85		0.94			1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00		0.98			1.00			1.00	1.00
Satd. Flow (prot)	1805	1900	1538		1760			3358			3538	1346
Flt Permitted	0.98	1.00	1.00		0.88			0.94			0.95	1.00
Satd. Flow (perm)	1856	1900	1538		1581			3154			3374	1346
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	5	5	21	11	5	11	11	253	5	5	505	5
RTOR Reduction (vph)	0	0	20	0	10	0	0	1	0	0	0	1
Lane Group Flow (vph)	5	5	1	0	17	0	0	268	0	0	510	4
Heavy Vehicles (%)	0%	0%	5%	0%	0%	0%	10%	7%	0%	0%	2%	20%
Turn Type	Perm		Perm	Perm			Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	4.4	4.4	4.4		4.4			80.6			80.6	80.6
Effective Green, g (s)	4.4	4.4	4.4		4.4			80.6			80.6	80.6
Actuated g/C Ratio	0.05	0.05	0.05		0.05			0.90			0.90	0.90
Clearance Time (s)	2.5	2.5	2.5		2.5			2.5			2.5	2.5
Vehicle Extension (s)	3.0	3.0	3.0		3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	91	93	75		77			2825			3022	1205
v/s Ratio Prot		0.00										
v/s Ratio Perm	0.00		0.00		c0.01			0.09			c0.15	0.00
v/c Ratio	0.05	0.05	0.01		0.21			0.10			0.17	0.00
Uniform Delay, d1	40.8	40.8	40.7		41.1			0.5			0.6	0.5
Progression Factor	1.00	1.00	1.00		1.00			0.63			1.00	1.00
Incremental Delay, d2	0.3	0.2	0.1		1.4			0.1			0.1	0.0
Delay (s)	41.1	41.1	40.8		42.5			0.4			0.7	0.5
Level of Service	D	D	D		D			A			A	A
Approach Delay (s)		40.9			42.5			0.4			0.7	
Approach LOS		D			D			A			A	

Intersection Summary			
HCM Average Control Delay	3.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.17		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	5.0
Intersection Capacity Utilization	31.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 No-Action Gardner
21: I-35 SB Ramps & Gardner Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	40	0	60	10	190	0	0	480	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				2.5		2.5		2.5			2.5	2.5
Lane Util. Factor				1.00		1.00		1.00			1.00	1.00
Frt				1.00		0.85		1.00			1.00	0.85
Flt Protected				0.95		1.00		1.00			1.00	1.00
Satd. Flow (prot)				1671		1380		1826			1863	1538
Flt Permitted				0.95		1.00		0.98			1.00	1.00
Satd. Flow (perm)				1671		1380		1790			1863	1538
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	43	0	64	11	202	0	0	511	43
RTOR Reduction (vph)	0	0	0	0	0	59	0	0	0	0	0	6
Lane Group Flow (vph)	0	0	0	43	0	5	0	213	0	0	511	37
Heavy Vehicles (%)	0%	0%	0%	8%	0%	17%	0%	4%	0%	0%	2%	5%
Turn Type				Prot		custom	Perm					Perm
Protected Phases				3				2			6	
Permitted Phases						3	2					6
Actuated Green, G (s)				6.7		6.7		78.3			78.3	78.3
Effective Green, g (s)				6.7		6.7		78.3			78.3	78.3
Actuated g/C Ratio				0.07		0.07		0.87			0.87	0.87
Clearance Time (s)				2.5		2.5		2.5			2.5	2.5
Vehicle Extension (s)				3.0		3.0		3.0			3.0	3.0
Lane Grp Cap (vph)				124		103		1557			1621	1338
v/s Ratio Prot				c0.03							c0.27	
v/s Ratio Perm						0.00		0.12				0.02
v/c Ratio				0.35		0.05		0.14			0.32	0.03
Uniform Delay, d1				39.6		38.7		0.9			1.0	0.8
Progression Factor				1.00		1.00		1.46			0.72	0.30
Incremental Delay, d2				1.7		0.2		0.2			0.5	0.0
Delay (s)				41.3		38.9		1.4			1.3	0.3
Level of Service				D		D		A			A	A
Approach Delay (s)		0.0			39.8			1.4			1.2	
Approach LOS		A			D			A			A	

Intersection Summary			
HCM Average Control Delay	6.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.32		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	5.0
Intersection Capacity Utilization	35.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 No-Action Gardner
22: I-35 NB Ramps & Gardner Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	0	10	0	0	0	0	130	180	410	110	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		2.5						2.5			2.5	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.98						0.92			1.00	
Flt Protected		0.96						1.00			0.96	
Satd. Flow (prot)		1757						1696			1792	
Flt Permitted		0.96						1.00			0.56	
Satd. Flow (perm)		1757						1696			1049	
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	88	0	11	0	0	0	0	143	198	451	121	0
RTOR Reduction (vph)	0	5	0	0	0	0	0	31	0	0	0	0
Lane Group Flow (vph)	0	94	0	0	0	0	0	310	0	0	572	0
Heavy Vehicles (%)	1%	0%	10%	0%	0%	0%	0%	5%	2%	2%	2%	0%
Turn Type	Perm									Perm		
Protected Phases		4						2			6	
Permitted Phases	4									6		
Actuated Green, G (s)		8.9						76.1			76.1	
Effective Green, g (s)		8.9						76.1			76.1	
Actuated g/C Ratio		0.10						0.85			0.85	
Clearance Time (s)		2.5						2.5			2.5	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		174						1434			887	
v/s Ratio Prot								0.18				
v/s Ratio Perm		0.05									c0.55	
v/c Ratio		0.54						0.22			0.64	
Uniform Delay, d1		38.6						1.3			2.4	
Progression Factor		1.00						1.00			1.06	
Incremental Delay, d2		3.2						0.3			3.5	
Delay (s)		41.8						1.7			6.0	
Level of Service		D						A			A	
Approach Delay (s)		41.8			0.0			1.7			6.0	
Approach LOS		D			A			A			A	

Intersection Summary			
HCM Average Control Delay	8.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	5.0
Intersection Capacity Utilization	61.4%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 No-Action Gardner
23: E 191st Street & Gardner Rd — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	10	300	0	5	130
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	11	323	0	5	140
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						220
pX, platoon unblocked						
vC, conflicting volume	473	323			323	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	473	323			323	
tC, single (s)	6.4	6.2			4.3	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.4	
p0 queue free %	100	99			100	
cM capacity (veh/h)	551	723			1143	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	11	323	145
Volume Left	0	0	5
Volume Right	11	0	0
cSH	723	1700	1143
Volume to Capacity	0.01	0.19	0.00
Queue Length 95th (ft)	1	0	0
Control Delay (s)	10.1	0.0	0.3
Lane LOS	B		A
Approach Delay (s)	10.1	0.0	0.3
Approach LOS	B		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	25.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Gardner
24: Sunflower Road & US 56 — AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	10	30	0	0	10	320	60	5	90	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	6	13	38	0	0	13	405	76	6	114	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	595	633	114	611	595	443	114			481		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	595	633	114	611	595	443	114			481		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	90	100	100	99			99		
cM capacity (veh/h)	414	394	944	390	414	619	1488			1092		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	25	38	494	120
Volume Left	6	38	13	6
Volume Right	13	0	76	0
cSH	566	390	1488	1092
Volume to Capacity	0.04	0.10	0.01	0.01
Queue Length 95th (ft)	4	8	1	0
Control Delay (s)	11.7	15.2	0.3	0.5
Lane LOS	B	C	A	A
Approach Delay (s)	11.7	15.2	0.3	0.5
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	35.6%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Gardner No Action - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 No-Action Gardner
25: US 56 & 4th Street — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	350	50	10	110	10	30
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	449	64	13	141	13	38
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			513		647	481
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			513		647	481
tC, single (s)			4.2		6.5	6.2
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.3
p0 queue free %			99		97	93
cM capacity (veh/h)			1013		418	583

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	513	154	51
Volume Left	0	13	13
Volume Right	64	0	38
cSH	1700	1013	531
Volume to Capacity	0.30	0.01	0.10
Queue Length 95th (ft)	0	1	8
Control Delay (s)	0.0	0.8	12.5
Lane LOS		A	B
Approach Delay (s)	0.0	0.8	12.5
Approach LOS			B

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	31.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Gardner
26: 199th Street & Four Corners Road — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	60	30	10	5	0
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	6	71	36	12	6	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	48				125	42
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	48				125	42
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	100
cM capacity (veh/h)	1573				871	1035

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	77	48	6
Volume Left	6	0	6
Volume Right	0	12	0
cSH	1573	1700	871
Volume to Capacity	0.00	0.03	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.6	0.0	9.2
Lane LOS	A		A
Approach Delay (s)	0.6	0.0	9.2
Approach LOS			A

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	17.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Gardner
27: 199th Street & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	60	20	10	5	20	40	10	230	10	30	60	30
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	67	22	11	6	22	45	11	258	11	34	67	34

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	101	73	281	135
Volume Left (vph)	67	6	11	34
Volume Right (vph)	11	45	11	34
Hadj (s)	0.11	-0.32	0.03	-0.07
Departure Headway (s)	5.1	4.7	4.5	4.6
Degree Utilization, x	0.14	0.10	0.35	0.17
Capacity (veh/h)	645	687	762	734
Control Delay (s)	8.9	8.2	10.0	8.6
Approach Delay (s)	8.9	8.2	10.0	8.6
Approach LOS	A	A	B	A

Intersection Summary			
Delay	9.3		
HCM Level of Service	A		
Intersection Capacity Utilization	37.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Gardner
30: US-56 & I-35 NB Loop — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	350	1420	0	490	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	393	1596	0	551	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			1989		669	197
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1989		669	197
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			294		396	818

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	197	197	1596	275	275
Volume Left	0	0	0	0	0
Volume Right	0	0	1596	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.12	0.12	0.94	0.16	0.16
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	91.3%	ICU Level of Service	F
Analysis Period (min)	15		

2010 Gardner No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

1: 175th Street & Waverly Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	60	290	5	0	50	50	5	80	5	90	20	10
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	72	349	6	0	60	60	6	96	6	108	24	12
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	120			355			611	617	352	642	590	90
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	120			355			611	617	352	642	590	90
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.2	6.5	6.3
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.4
p0 queue free %	95			100			98	75	99	63	94	99
cM capacity (veh/h)	1449			1214			370	384	696	295	396	946

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	428	120	108	145
Volume Left	72	0	6	108
Volume Right	6	60	6	12
cSH	1449	1214	393	328
Volume to Capacity	0.05	0.00	0.28	0.44
Queue Length 95th (ft)	4	0	28	54
Control Delay (s)	1.7	0.0	17.6	24.4
Lane LOS	A		C	C
Approach Delay (s)	1.7	0.0	17.6	24.4
Approach LOS			C	C

Intersection Summary			
Average Delay	7.7		
Intersection Capacity Utilization	45.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

2: US 56 & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	550	60	100	210	100	70	320	190	140	200	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.99			0.96		1.00	0.94		1.00	0.99	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3393			3188		1805	1725		1736	1808	
Flt Permitted		0.89			0.63		0.60	1.00		0.25	1.00	
Satd. Flow (perm)		3043			2020		1144	1725		460	1808	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	46	632	69	115	241	115	80	368	218	161	230	23
RTOR Reduction (vph)	0	16	0	0	64	0	0	31	0	0	5	0
Lane Group Flow (vph)	0	731	0	0	407	0	80	555	0	161	248	0
Heavy Vehicles (%)	3%	5%	2%	7%	9%	6%	0%	4%	4%	4%	4%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		17.7			17.7		19.4	19.4		19.4	19.4	
Effective Green, g (s)		17.7			17.7		19.4	19.4		19.4	19.4	
Actuated g/C Ratio		0.36			0.36		0.40	0.40		0.40	0.40	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1104			733		455	686		183	719	
v/s Ratio Prot								0.32			0.14	
v/s Ratio Perm		c0.24			0.20		0.07			c0.35		
v/c Ratio		0.66			0.55		0.18	0.81		0.88	0.34	
Uniform Delay, d1		13.0			12.4		9.5	13.1		13.6	10.3	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.5			0.9		0.2	7.0		34.7	0.3	
Delay (s)		14.5			13.3		9.7	20.0		48.3	10.5	
Level of Service		B			B		A	C		D	B	
Approach Delay (s)		14.5			13.3			18.8			25.2	
Approach LOS		B			B			B			C	

Intersection Summary			
HCM Average Control Delay	17.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	48.8	Sum of lost time (s)	11.7
Intersection Capacity Utilization	86.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

3: US 56 & Elm — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	870	10	10	380	40	10	5	20	70	5	20
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			0.99			0.92			0.97	
Flt Protected		1.00			1.00			0.99			0.96	
Satd. Flow (prot)		3615			3467			1817			1853	
Flt Permitted		0.94			0.93			0.91			0.76	
Satd. Flow (perm)		3407			3238			1677			1458	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	22	935	11	11	409	43	11	5	22	75	5	22
RTOR Reduction (vph)	0	1	0	0	7	0	0	19	0	0	19	0
Lane Group Flow (vph)	0	967	0	0	456	0	0	19	0	0	83	0
Heavy Vehicles (%)	0%	5%	0%	0%	9%	0%	0%	0%	0%	0%	0%	5%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		30.9			30.9			6.1			6.1	
Effective Green, g (s)		30.9			30.9			6.1			6.1	
Actuated g/C Ratio		0.67			0.67			0.13			0.13	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2289			2175			222			193	
v/s Ratio Prot												
v/s Ratio Perm		c0.28			0.14			0.01			c0.06	
v/c Ratio		0.42			0.21			0.09			0.43	
Uniform Delay, d1		3.5			2.9			17.5			18.3	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.1			0.0			0.2			1.5	
Delay (s)		3.6			2.9			17.7			19.9	
Level of Service		A			A			B			B	
Approach Delay (s)		3.6			2.9			17.7			19.9	
Approach LOS		A			A			B			B	

Intersection Summary			
HCM Average Control Delay	4.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	46.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	55.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

4: US 56 & Mulberry — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	950	10	10	380	50	5	5	20	90	5	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			0.98			0.91			0.97	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3459			3287			1605			1737	
Flt Permitted		0.93			0.93			0.95			0.77	
Satd. Flow (perm)		3234			3062			1530			1378	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	32	1022	11	11	409	54	5	5	22	97	5	32
RTOR Reduction (vph)	0	1	0	0	14	0	0	18	0	0	24	0
Lane Group Flow (vph)	0	1064	0	0	460	0	0	14	0	0	110	0
Heavy Vehicles (%)	7%	4%	0%	0%	8%	8%	0%	20%	5%	2%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		33.0			33.0			8.0			8.0	
Effective Green, g (s)		33.0			33.0			8.0			8.0	
Actuated g/C Ratio		0.66			0.66			0.16			0.16	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2134			2021			245			220	
v/s Ratio Prot												
v/s Ratio Perm		c0.33			0.15			0.01			c0.08	
v/c Ratio		0.50			0.23			0.06			0.50	
Uniform Delay, d1		4.3			3.4			17.8			19.2	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.2			0.1			0.1			1.8	
Delay (s)		4.5			3.5			17.9			20.9	
Level of Service		A			A			B			C	
Approach Delay (s)		4.5			3.5			17.9			20.9	
Approach LOS		A			A			B			C	

Intersection Summary			
HCM Average Control Delay	5.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	50.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	69.6%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

2010 Gardner No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

5: US 56 & Moonlight Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	60	910	130	40	290	160	120	120	110	430	150	50
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1752	3619	1568	1752	3282	1583	1752	3505	1538	3400	3505	1553
Flt Permitted	0.55	1.00	1.00	0.21	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1011	3619	1568	379	3282	1583	1752	3505	1538	3400	3505	1553
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	66	1000	143	44	319	176	132	132	121	473	165	55
RTOR Reduction (vph)	0	0	74	0	0	93	0	0	99	0	0	48
Lane Group Flow (vph)	66	1000	69	44	319	83	132	132	22	473	165	7
Heavy Vehicles (%)	3%	5%	3%	3%	10%	2%	3%	3%	5%	3%	3%	4%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		Perm
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			4
Actuated Green, G (s)	45.3	43.3	43.3	43.7	42.5	42.5	11.1	5.5	5.5	17.0	11.4	11.4
Effective Green, g (s)	45.3	43.3	43.3	43.7	42.5	42.5	11.1	5.5	5.5	17.0	11.4	11.4
Actuated g/C Ratio	0.50	0.48	0.48	0.49	0.47	0.47	0.12	0.06	0.06	0.19	0.13	0.13
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	525	1741	754	202	1550	748	216	214	94	642	444	197
v/s Ratio Prot	0.00	c0.28		c0.00	0.10		0.08	c0.04		c0.14	0.05	
v/s Ratio Perm	0.06		0.04	0.10		0.05			0.01			0.00
v/c Ratio	0.13	0.57	0.09	0.22	0.21	0.11	0.61	0.62	0.24	0.74	0.37	0.04
Uniform Delay, d1	11.5	16.7	12.7	13.1	13.9	13.2	37.4	41.2	40.3	34.4	36.0	34.5
Progression Factor	1.00	1.00	1.00	0.66	0.62	0.21	0.94	0.96	0.90	1.00	1.00	1.00
Incremental Delay, d2	0.0	1.4	0.2	0.2	0.3	0.3	3.5	3.7	0.5	3.8	0.2	0.0
Delay (s)	11.6	18.1	12.9	8.8	8.9	3.1	38.6	43.4	36.5	38.2	36.2	34.5
Level of Service	B	B	B	A	A	A	D	D	D	D	D	C
Approach Delay (s)		17.2			7.0			39.6			37.4	
Approach LOS		B			A			D			D	

Intersection Summary			
HCM Average Control Delay	23.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	16.5
Intersection Capacity Utilization	67.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
2010 Gardner No-Action - (Improved)

6: Old US 56 & US 56

AM Peak Hour

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	40	10	1240	210	10	470
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	4.0	5.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1752	1615	3654	1568	1805	3551
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1752	1615	3654	1568	1805	3551
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	41	10	1278	216	10	485
RTOR Reduction (vph)	0	9	0	84	0	0
Lane Group Flow (vph)	41	1	1278	132	10	485
Heavy Vehicles (%)	3%	0%	4%	3%	0%	7%
Turn Type		Perm		custom	Prot	
Protected Phases	8		2	4	1	6
Permitted Phases		8				
Actuated Green, G (s)	12.7	12.7	61.9	12.7	1.4	67.3
Effective Green, g (s)	12.7	12.7	61.9	12.7	1.4	67.3
Actuated g/C Ratio	0.14	0.14	0.69	0.14	0.02	0.75
Clearance Time (s)	5.0	5.0	5.0	5.0	4.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	247	228	2513	221	28	2655
v/s Ratio Prot	0.02		c0.35	c0.08	0.01	c0.14
v/s Ratio Perm		0.00				
v/c Ratio	0.17	0.01	0.51	0.60	0.36	0.18
Uniform Delay, d1	34.0	33.2	6.7	36.2	43.9	3.3
Progression Factor	1.00	1.00	0.89	0.87	1.06	0.51
Incremental Delay, d2	0.3	0.0	0.6	3.7	6.8	0.1
Delay (s)	34.3	33.2	6.6	35.2	53.2	1.8
Level of Service	C	C	A	D	D	A
Approach Delay (s)	34.1		10.8			2.9
Approach LOS	C		B			A

Intersection Summary			
HCM Average Control Delay	9.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	46.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
2010 Gardner No-Action - (Improved)

7: US-56 & Cedar Niles

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	1270	90	230	1100	60	80	20	450	40	10	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00		1.00	0.88	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85	1.00	0.88	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1805	3689	1615	3433	3689	1615		1827	2842	1752	1606	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.73	1.00	0.68	1.00	
Satd. Flow (perm)	1805	3689	1615	3433	3689	1615		1387	2842	1262	1606	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	45	1427	101	258	1236	67	90	22	506	45	11	45
RTOR Reduction (vph)	0	0	44	0	0	24	0	0	0	0	39	0
Lane Group Flow (vph)	45	1427	57	258	1236	43	0	112	506	45	17	0
Heavy Vehicles (%)	0%	3%	0%	2%	3%	0%	0%	0%	0%	3%	0%	5%
Turn Type	Prot		Perm	Prot		Perm	Perm		pt+ov	Perm		
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases			2			6	8			4		
Actuated Green, G (s)	4.8	50.4	50.4	12.6	58.2	58.2		11.4	28.0	11.4	11.4	
Effective Green, g (s)	4.8	50.4	50.4	12.6	58.2	58.2		11.4	24.0	11.4	11.4	
Actuated g/C Ratio	0.05	0.56	0.56	0.14	0.65	0.65		0.13	0.27	0.13	0.13	
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2		5.2	5.2	
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0		1.0		1.0	1.0	
Lane Grp Cap (vph)	96	2066	904	481	2386	1044		176	758	160	203	
v/s Ratio Prot	0.02	c0.39		0.08	0.34				c0.18		0.01	
v/s Ratio Perm			0.04			0.03		0.08		0.04		
v/c Ratio	0.47	0.69	0.06	0.54	0.52	0.04		0.64	0.67	0.28	0.08	
Uniform Delay, d1	41.4	14.2	9.0	36.0	8.4	5.8		37.3	29.4	35.6	34.7	
Progression Factor	1.07	1.16	2.02	1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	1.2	1.8	0.1	0.6	0.8	0.1		5.4	1.7	0.4	0.1	
Delay (s)	45.4	18.2	18.3	36.6	9.3	5.8		42.8	31.2	35.9	34.7	
Level of Service	D	B	B	D	A	A		D	C	D	C	
Approach Delay (s)		19.0			13.6			33.3			35.3	
Approach LOS		B			B			C			D	

Intersection Summary			
HCM Average Control Delay	19.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	16.8
Intersection Capacity Utilization	71.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
2010 Gardner No-Action - (Improved)

8: US-56 & I-35 SB Ramps

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1710	40	20	470	0	0	0	0	50	0	920
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		1.00		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3513		1641	3689					1641		2760
Flt Permitted		1.00		0.95	1.00					0.95		1.00
Satd. Flow (perm)		3513		1641	3689					1641		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1800	42	21	495	0	0	0	0	53	0	968
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	74
Lane Group Flow (vph)	0	1840	0	21	495	0	0	0	0	53	0	894
Heavy Vehicles (%)	0%	2%	20%	10%	3%	0%	0%	0%	0%	10%	0%	3%
Turn Type	Prot			Prot						custom		custom
Protected Phases	5	2		1	6							5
Permitted Phases										4		4
Actuated Green, G (s)		32.8		1.4	13.2					2.8		23.8
Effective Green, g (s)		32.8		1.4	13.2					2.8		23.8
Actuated g/C Ratio		0.63		0.03	0.25					0.05		0.46
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2216		44	936					88		1529
v/s Ratio Prot		c0.52		0.01	c0.13							c0.24
v/s Ratio Perm										0.03		0.09
v/c Ratio		0.83		0.48	0.53					0.60		0.58
Uniform Delay, d1		7.4		24.9	16.7					24.1		10.4
Progression Factor		1.00		1.00	1.00					1.00		1.00
Incremental Delay, d2		3.8		7.9	2.1					11.1		0.6
Delay (s)		11.2		32.9	18.9					35.1		11.0
Level of Service		B		C	B					D		B
Approach Delay (s)		11.2			19.4			0.0			12.3	
Approach LOS		B			B			A			B	

Intersection Summary			
HCM Average Control Delay	12.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	52.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	59.4%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

9: US-56 & I-35 NB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	350	0	0	350	130	150	5	90	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			0.96			0.95				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3725			1807			1648				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3725			1807			1648				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	398	0	0	398	148	170	6	102	0	0	0
RTOR Reduction (vph)	0	0	0	0	28	0	0	61	0	0	0	0
Lane Group Flow (vph)	0	398	0	0	518	0	0	217	0	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	1%	2%	8%	0%	4%	0%	0%	0%
Turn Type							Perm					
Protected Phases		2			6			8				
Permitted Phases							8					
Actuated Green, G (s)		19.5			19.5			10.5				
Effective Green, g (s)		19.5			19.5			10.5				
Actuated g/C Ratio		0.49			0.49			0.26				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		1816			881			433				
v/s Ratio Prot		0.11			c0.29							
v/s Ratio Perm								0.13				
v/c Ratio		0.22			0.59			0.50				
Uniform Delay, d1		5.9			7.4			12.5				
Progression Factor		1.00			1.00			1.00				
Incremental Delay, d2		0.3			2.9			0.9				
Delay (s)		6.2			10.2			13.4				
Level of Service		A			B			B				
Approach Delay (s)		6.2			10.2			13.4			0.0	
Approach LOS		A			B			B			A	

Intersection Summary			
HCM Average Control Delay	9.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	40.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	91.3%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

10: Sante Fe & Moonlight Road — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	40	90	260	70	120	190
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.97		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1752	1583	3382		1770	3471
Flt Permitted	0.95	1.00	1.00		0.54	1.00
Satd. Flow (perm)	1752	1583	3382		1005	3471
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	43	97	280	75	129	204
RTOR Reduction (vph)	0	90	14	0	0	0
Lane Group Flow (vph)	43	7	341	0	129	204
Heavy Vehicles (%)	3%	2%	4%	1%	2%	4%
Turn Type		Perm			Perm	
Protected Phases	6		8			4
Permitted Phases		6			4	
Actuated Green, G (s)	6.5	6.5	73.5		73.5	73.5
Effective Green, g (s)	6.5	6.5	73.5		73.5	73.5
Actuated g/C Ratio	0.07	0.07	0.82		0.82	0.82
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	127	114	2762		821	2835
v/s Ratio Prot	c0.02		0.10			0.06
v/s Ratio Perm		0.00			c0.13	
v/c Ratio	0.34	0.06	0.12		0.16	0.07
Uniform Delay, d1	39.7	38.9	1.7		1.7	1.6
Progression Factor	1.00	1.00	1.00		0.73	0.55
Incremental Delay, d2	1.6	0.2	0.1		0.4	0.0
Delay (s)	41.3	39.1	1.8		1.7	0.9
Level of Service	D	D	A		A	A
Approach Delay (s)	39.8		1.8			1.2
Approach LOS	D		A			A

Intersection Summary			
HCM Average Control Delay	8.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.17		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	34.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

11: Waverly Road & US 56 — AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	20	0	10	5	10	60	250	0	5	80	10
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	25	0	13	6	13	76	316	0	6	101	13
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	604	595	316	601	589	108	114			316		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	604	595	316	601	589	108	114			316		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.3	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.4	2.2			2.2		
p0 queue free %	100	94	100	97	98	99	95			99		
cM capacity (veh/h)	385	396	729	378	400	925	1469			1255		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	25	32	392	120
Volume Left	0	13	76	6
Volume Right	0	13	0	13
cSH	396	502	1469	1255
Volume to Capacity	0.06	0.06	0.05	0.01
Queue Length 95th (ft)	5	5	4	0
Control Delay (s)	14.7	12.7	1.9	0.5
Lane LOS	B	B	A	A
Approach Delay (s)	14.7	12.7	1.9	0.5
Approach LOS	B	B		

Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	37.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

12: 183rd Street & Four Corners Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	5	5	5	10	5	10	10	5	5	10	5
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	5	5	11	5	11	11	5	5	11	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	16	22	27	22
Volume Left (vph)	5	5	11	5
Volume Right (vph)	5	5	5	5
Hadj (s)	-0.13	-0.10	-0.04	-0.10
Departure Headway (s)	3.9	3.9	4.0	3.9
Degree Utilization, x	0.02	0.02	0.03	0.02
Capacity (veh/h)	907	902	887	907
Control Delay (s)	7.0	7.0	7.1	7.0
Approach Delay (s)	7.0	7.0	7.1	7.0
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.0		
HCM Level of Service	A		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Gardner No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)
13: 183rd Street & US 56 — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✥			✥			✥			✥	
Volume (veh/h)	5	10	5	10	10	5	0	310	10	0	80	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	13	6	13	13	6	0	392	13	0	101	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	516	509	104	516	506	399	108			405		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	516	509	104	516	506	399	108			405		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	97	99	97	97	99	100			100		
cM capacity (veh/h)	459	470	956	460	472	655	1496			1165		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	25	32	405	108
Volume Left	6	13	0	0
Volume Right	6	6	13	6
cSH	534	494	1496	1165
Volume to Capacity	0.05	0.06	0.00	0.00
Queue Length 95th (ft)	4	5	0	0
Control Delay (s)	12.1	12.8	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	12.1	12.8	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	26.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)
14: 183rd Street & Waverly Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✥			✥			✥			✥	
Volume (veh/h)	0	10	5	5	20	10	5	5	5	5	5	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	11	5	5	22	11	5	5	5	5	5	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	33			16			54	57	14	60	54	27
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	33			16			54	57	14	60	54	27
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			99	99	99	99	99	100
cM capacity (veh/h)	1592			1614			942	835	1072	929	838	1054

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	16	38	16	11
Volume Left	0	5	5	5
Volume Right	5	11	5	0
cSH	1592	1614	940	881
Volume to Capacity	0.00	0.00	0.02	0.01
Queue Length 95th (ft)	0	0	1	1
Control Delay (s)	0.0	1.1	8.9	9.1
Lane LOS		A	A	A
Approach Delay (s)	0.0	1.1	8.9	9.1
Approach LOS			A	A

Intersection Summary			
Average Delay	3.5		
Intersection Capacity Utilization	16.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)
15: 183rd Street & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Volume (vph)	40	10	80	110	20	90	20	410	40	30	340	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.87		1.00	0.88		1.00	0.99		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1805	1646		1805	1666		1805	3437		1805	3482	
Flt Permitted	0.68	1.00		0.69	1.00		0.51	1.00		0.47	1.00	
Satd. Flow (perm)	1288	1646		1314	1666		977	3437		885	3482	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	45	11	90	124	22	101	22	461	45	34	382	22
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	45	101	0	124	123	0	22	506	0	34	404	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	4%	0%	0%	3%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	7.0	7.0		7.0	7.0		13.1	13.1		13.1	13.1	
Effective Green, g (s)	7.0	7.0		7.0	7.0		13.1	13.1		13.1	13.1	
Actuated g/C Ratio	0.23	0.23		0.23	0.23		0.44	0.44		0.44	0.44	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	300	383		306	387		425	1496		385	1515	
v/s Ratio Prot		0.06			0.07			c0.15			0.12	
v/s Ratio Perm	0.03			c0.09			0.02			0.04		
v/c Ratio	0.15	0.26		0.41	0.32		0.05	0.34		0.09	0.27	
Uniform Delay, d1	9.2	9.4		9.8	9.6		4.9	5.6		5.0	5.4	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.2	0.4		0.9	0.5		0.1	0.1		0.1	0.1	
Delay (s)	9.4	9.8		10.7	10.0		5.0	5.8		5.1	5.5	
Level of Service	A	A		B	B		A	A		A	A	
Approach Delay (s)		9.7			10.4			5.7			5.5	
Approach LOS		A			B			A			A	

Intersection Summary			
HCM Average Control Delay	6.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.36		
Actuated Cycle Length (s)	30.1	Sum of lost time (s)	10.0
Intersection Capacity Utilization	43.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)
16: Four Corners Road & US 56 — AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✥			✥			✥			✥	
Volume (veh/h)	5	5	10	0	10	5	10	310	0	5	90	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	7	7	13	0	13	7	13	408	0	7	118	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	579	566	408	582	566	118	118			408		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	579	566	408	582	566	118	118			408		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	98	100	97	99	99			99		
cM capacity (veh/h)	412	430	648	409	430	939	1482			1162		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	26	20	421	125
Volume Left	7	0	13	7
Volume Right	13	7	0	0
cSH	510	525	1482	1162
Volume to Capacity	0.05	0.04	0.01	0.01
Queue Length 95th (ft)	4	3	1	0
Control Delay (s)	12.4	12.1	0.3	0.5
Lane LOS	B	B	A	A
Approach Delay (s)	12.4	12.1	0.3	0.5
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.3		
Intersection Capacity Utilization	31.8%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Gardner No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

17: 191st Street & US 56 — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	10	10	5	0	0	5	0	320	5	0	90	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	13	13	6	0	0	6	0	416	6	0	117	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	545	542	120	552	542	419	123			422		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	545	542	120	552	542	419	123			422		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	97	99	100	100	99	100			100		
cM capacity (veh/h)	447	450	937	435	450	639	1476			1148		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	32	6	422	123
Volume Left	13	0	0	0
Volume Right	6	6	6	6
cSH	501	639	1476	1148
Volume to Capacity	0.06	0.01	0.00	0.00
Queue Length 95th (ft)	5	1	0	0
Control Delay (s)	12.7	10.7	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	12.7	10.7	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	31.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

18: 191st Street & Four Corners Road — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	5	10	10	10	10	10
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	11	11	11	11	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	49	16			22	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	49	16			22	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	99			99	
cM capacity (veh/h)	959	1069			1607	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	16	22	22
Volume Left	5	0	11
Volume Right	11	11	0
cSH	1029	1700	1607
Volume to Capacity	0.02	0.01	0.01
Queue Length 95th (ft)	1	0	1
Control Delay (s)	8.6	0.0	3.7
Lane LOS	A		A
Approach Delay (s)	8.6	0.0	3.7
Approach LOS	A		

Intersection Summary			
Average Delay	3.7		
Intersection Capacity Utilization	17.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

19: 191st Street & Waverly Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	20	5	5	10	5	5	5	5	5	5	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	22	5	5	11	5	5	5	5	5	5	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	16			27			68	62	24	68	62	14
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	16			27			68	62	24	68	62	14
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			99	99	99	99	99	99
cM capacity (veh/h)	1614			1600			916	827	1058	915	827	1072

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	33	22	16	16
Volume Left	5	5	5	5
Volume Right	5	5	5	5
cSH	1614	1600	924	927
Volume to Capacity	0.00	0.00	0.02	0.02
Queue Length 95th (ft)	0	0	1	1
Control Delay (s)	1.2	1.8	9.0	9.0
Lane LOS	A	A	A	A
Approach Delay (s)	1.2	1.8	9.0	9.0
Approach LOS			A	A

Intersection Summary			
Average Delay	4.3		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

20: W 191st Street & Gardner Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	5	5	20	10	5	10	10	240	5	5	480	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00			0.95			0.95	1.00
Frt	1.00	1.00	0.85		0.94			1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00		0.98			1.00			1.00	1.00
Satd. Flow (prot)	1805	1900	1538		1760			3358			3538	1346
Flt Permitted	1.00	1.00	1.00		0.94			0.94			0.95	1.00
Satd. Flow (perm)	1900	1900	1538		1685			3151			3373	1346
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	5	5	21	11	5	11	11	253	5	5	505	5
RTOR Reduction (vph)	0	0	20	0	11	0	0	1	0	0	0	1
Lane Group Flow (vph)	5	5	1	0	16	0	0	268	0	0	510	4
Heavy Vehicles (%)	0%	0%	5%	0%	0%	0%	10%	7%	0%	0%	2%	20%
Turn Type	Perm		Perm	Perm			Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	3.0	3.0	3.0		3.0			57.0			57.0	57.0
Effective Green, g (s)	3.0	3.0	3.0		3.0			57.0			57.0	57.0
Actuated g/C Ratio	0.04	0.04	0.04		0.04			0.81			0.81	0.81
Clearance Time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	81	81	66		72			2566			2747	1096
v/s Ratio Prot		0.00										
v/s Ratio Perm	0.00		0.00		c0.01			0.09			c0.15	0.00
v/c Ratio	0.06	0.06	0.01		0.23			0.10			0.19	0.00
Uniform Delay, d1	32.1	32.1	32.1		32.4			1.3			1.4	1.2
Progression Factor	1.00	1.00	1.00		1.00			0.75			1.00	1.00
Incremental Delay, d2	0.3	0.3	0.1		1.6			0.1			0.1	0.0
Delay (s)	32.5	32.5	32.2		34.0			1.1			1.6	1.2
Level of Service	C	C	C		C			A			A	A
Approach Delay (s)		32.3			34.0			1.1			1.6	
Approach LOS		C			C			A			A	

Intersection Summary			
HCM Average Control Delay	3.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.19		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	37.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

21: I-35 SB Ramps & Gardner Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	40	0	60	10	190	0	0	480	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0		5.0		5.0			5.0	5.0
Lane Util. Factor				1.00		1.00		1.00			1.00	1.00
Frt				1.00		0.85		1.00			1.00	0.85
Flt Protected				0.95		1.00		1.00			1.00	1.00
Satd. Flow (prot)				1671		1380		1826			1863	1538
Flt Permitted				0.95		1.00		0.98			1.00	1.00
Satd. Flow (perm)				1671		1380		1787			1863	1538
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	43	0	64	11	202	0	0	511	43
RTOR Reduction (vph)	0	0	0	0	0	58	0	0	0	0	0	10
Lane Group Flow (vph)	0	0	0	43	0	6	0	213	0	0	511	33
Heavy Vehicles (%)	0%	0%	0%	8%	0%	17%	0%	4%	0%	0%	2%	5%
Turn Type				Prot		custom	Perm					Perm
Protected Phases				3				2			6	
Permitted Phases						3	2					6
Actuated Green, G (s)				6.4		6.4		53.6			53.6	53.6
Effective Green, g (s)				6.4		6.4		53.6			53.6	53.6
Actuated g/C Ratio				0.09		0.09		0.77			0.77	0.77
Clearance Time (s)				5.0		5.0		5.0			5.0	5.0
Vehicle Extension (s)				3.0		3.0		3.0			3.0	3.0
Lane Grp Cap (vph)				153		126		1368			1427	1178
v/s Ratio Prot				c0.03							c0.27	
v/s Ratio Perm						0.00		0.12				0.02
v/c Ratio				0.28		0.05		0.16			0.36	0.03
Uniform Delay, d1				29.7		29.0		2.2			2.6	2.0
Progression Factor				1.00		1.00		0.76			0.94	0.83
Incremental Delay, d2				1.0		0.2		0.2			0.7	0.0
Delay (s)				30.7		29.2		1.9			3.2	1.7
Level of Service				C		C		A			A	A
Approach Delay (s)		0.0			29.8			1.9			3.1	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM Average Control Delay	6.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.35		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	36.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

22: I-35 NB Ramps & Gardner Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	0	10	0	0	0	0	130	180	410	110	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.98						0.92			1.00	
Flt Protected		0.96						1.00			0.96	
Satd. Flow (prot)		1757						1696			1792	
Flt Permitted		0.96						1.00			0.57	
Satd. Flow (perm)		1757						1696			1060	
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	88	0	11	0	0	0	0	143	198	451	121	0
RTOR Reduction (vph)	0	6	0	0	0	0	0	44	0	0	0	0
Lane Group Flow (vph)	0	93	0	0	0	0	0	297	0	0	572	0
Heavy Vehicles (%)	1%	0%	10%	0%	0%	0%	0%	5%	2%	2%	2%	0%
Turn Type	Perm									Perm		
Protected Phases		4						2			6	
Permitted Phases	4									6		
Actuated Green, G (s)		5.6						54.4			54.4	
Effective Green, g (s)		5.6						54.4			54.4	
Actuated g/C Ratio		0.08						0.78			0.78	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		141						1318			824	
v/s Ratio Prot								0.18				
v/s Ratio Perm		0.05									c0.54	
v/c Ratio		0.66						0.23			0.69	
Uniform Delay, d1		31.3						2.1			3.8	
Progression Factor		1.00						1.00			0.82	
Incremental Delay, d2		10.5						0.4			4.6	
Delay (s)		41.8						2.5			7.7	
Level of Service		D						A			A	
Approach Delay (s)		41.8			0.0			2.5			7.7	
Approach LOS		D			A			A			A	

Intersection Summary			
HCM Average Control Delay	9.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

23: E 191st Street & Gardner Rd

AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	10	300	0	5	130
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	11	323	0	5	140
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						220
pX, platoon unblocked						
vC, conflicting volume	473	323			323	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	473	323			323	
tC, single (s)	6.4	6.2			4.3	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.4	
p0 queue free %	100	99			100	
cM capacity (veh/h)	551	723			1143	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	11	323	145
Volume Left	0	0	5
Volume Right	11	0	0
cSH	723	1700	1143
Volume to Capacity	0.01	0.19	0.00
Queue Length 95th (ft)	1	0	0
Control Delay (s)	10.1	0.0	0.3
Lane LOS	B		A
Approach Delay (s)	10.1	0.0	0.3
Approach LOS	B		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	25.8%	ICU Level of Service	A
Analysis Period (min)	15		

24: Sunflower Road & US 56

AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	10	30	0	0	10	320	60	5	90	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	6	13	38	0	0	13	405	76	6	114	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	595	633	114	611	595	443	114			481		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	595	633	114	611	595	443	114			481		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	90	100	100	99			99		
cM capacity (veh/h)	414	394	944	390	414	619	1488			1092		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	25	38	494	120
Volume Left	6	38	13	6
Volume Right	13	0	76	0
cSH	566	390	1488	1092
Volume to Capacity	0.04	0.10	0.01	0.01
Queue Length 95th (ft)	4	8	1	0
Control Delay (s)	11.7	15.2	0.3	0.5
Lane LOS	B	C	A	A
Approach Delay (s)	11.7	15.2	0.3	0.5
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	35.6%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Gardner No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)
25: US 56 & 4th Street — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	350	50	10	110	10	30
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	449	64	13	141	13	38
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			513		647	481
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			513		647	481
tC, single (s)			4.2		6.5	6.2
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.3
p0 queue free %			99		97	93
cM capacity (veh/h)			1013		418	583

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	513	154	51
Volume Left	0	13	13
Volume Right	64	0	38
cSH	1700	1013	531
Volume to Capacity	0.30	0.01	0.10
Queue Length 95th (ft)	0	1	8
Control Delay (s)	0.0	0.8	12.5
Lane LOS		A	B
Approach Delay (s)	0.0	0.8	12.5
Approach LOS			B

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	31.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)
26: 199th Street & Four Corners Road — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	60	30	10	5	0
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	6	71	36	12	6	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	48				125	42
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	48				125	42
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	100
cM capacity (veh/h)	1573				871	1035

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	77	48	6
Volume Left	6	0	6
Volume Right	0	12	0
cSH	1573	1700	871
Volume to Capacity	0.00	0.03	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.6	0.0	9.2
Lane LOS	A		A
Approach Delay (s)	0.6	0.0	9.2
Approach LOS			A

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	17.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)
27: 199th Street & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	60	20	10	5	20	40	10	230	10	30	60	30
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	67	22	11	6	22	45	11	258	11	34	67	34

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	101	73	281	135
Volume Left (vph)	67	6	11	34
Volume Right (vph)	11	45	11	34
Hadj (s)	0.11	-0.32	0.03	-0.07
Departure Headway (s)	5.1	4.7	4.5	4.6
Degree Utilization, x	0.14	0.10	0.35	0.17
Capacity (veh/h)	645	687	762	734
Control Delay (s)	8.9	8.2	10.0	8.6
Approach Delay (s)	8.9	8.2	10.0	8.6
Approach LOS	A	A	B	A

Intersection Summary			
Delay	9.3		
HCM Level of Service	A		
Intersection Capacity Utilization	37.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)
30: US-56 & I-35 NB Loop — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	350	1420	0	490	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	393	1596	0	551	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked						
vC, conflicting volume			1989		669	197
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1989		669	197
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			294		396	818

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	197	197	1596	275	275
Volume Left	0	0	0	0	0
Volume Right	0	0	1596	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.12	0.12	0.94	0.16	0.16
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	91.3%	ICU Level of Service	F
Analysis Period (min)	15		

2010 Gardner No Action - PM Peak Hour - Synchro Intersection LOS

1: 175th Street & Waverly Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	90	5	5	280	80	10	20	5	30	20	20
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	12	108	6	6	337	96	12	24	6	36	24	24
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	434			114			569	581	111	551	536	386
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	434			114			569	581	111	551	536	386
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			100			97	94	99	91	95	96
cM capacity (veh/h)	1137			1487			398	421	947	417	447	667

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	127	440	42	84
Volume Left	12	6	12	36
Volume Right	6	96	6	24
cSH	1137	1487	450	477
Volume to Capacity	0.01	0.00	0.09	0.18
Queue Length 95th (ft)	1	0	8	16
Control Delay (s)	0.9	0.1	13.8	14.2
Lane LOS	A	A	B	B
Approach Delay (s)	0.9	0.1	13.8	14.2
Approach LOS			B	B

Intersection Summary			
Average Delay	2.8		
Intersection Capacity Utilization	33.6%	ICU Level of Service	A
Analysis Period (min)	15		

2: US 56 & Gardner Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	270	50	210	630	220	60	150	140	140	150	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.98			0.97		1.00	0.93		1.00	0.97	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3301			3389		1770	1694		1736	1773	
Flt Permitted		0.86			0.77		0.62	1.00		0.44	1.00	
Satd. Flow (perm)		2837			2650		1158	1694		813	1773	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	23	310	57	241	724	253	69	172	161	161	172	46
RTOR Reduction (vph)	0	22	0	0	38	0	0	60	0	0	17	0
Lane Group Flow (vph)	0	368	0	0	1180	0	69	273	0	161	201	0
Heavy Vehicles (%)	0%	8%	2%	1%	3%	1%	2%	4%	4%	4%	4%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		27.6			27.6		15.2	15.2		15.2	15.2	
Effective Green, g (s)		27.6			27.6		15.2	15.2		15.2	15.2	
Actuated g/C Ratio		0.51			0.51		0.28	0.28		0.28	0.28	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1437			1342		323	472		227	494	
v/s Ratio Prot								0.16			0.11	
v/s Ratio Perm		0.13			c0.45		0.06			c0.20		
v/c Ratio		0.26			0.88		0.21	0.58		0.71	0.41	
Uniform Delay, d1		7.6			12.0		15.1	16.9		17.7	16.0	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.1			6.9		0.3	1.7		9.7	0.5	
Delay (s)		7.7			18.9		15.4	18.6		27.4	16.5	
Level of Service		A			B		B	B		C	B	
Approach Delay (s)		7.7			18.9			18.1			21.1	
Approach LOS		A			B			B			C	

Intersection Summary			
HCM Average Control Delay	17.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	54.5	Sum of lost time (s)	11.7
Intersection Capacity Utilization	84.5%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

3: US 56 & Elm

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	560	20	30	1030	40	20	10	40	60	10	30
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		0.99			0.99			0.92			0.96	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3574			3702			1765			1842	
Flt Permitted		0.93			0.93			0.90			0.81	
Satd. Flow (perm)		3337			3444			1606			1544	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	11	602	22	32	1108	43	22	11	43	65	11	32
RTOR Reduction (vph)	0	2	0	0	3	0	0	36	0	0	27	0
Lane Group Flow (vph)	0	633	0	0	1180	0	0	40	0	0	81	0
Heavy Vehicles (%)	0%	6%	0%	3%	2%	0%	5%	0%	3%	2%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		33.0			33.0			8.2			8.2	
Effective Green, g (s)		33.0			33.0			8.2			8.2	
Actuated g/C Ratio		0.66			0.66			0.16			0.16	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2194			2264			262			252	
v/s Ratio Prot												
v/s Ratio Perm		0.19			c0.34			0.02			c0.05	
v/c Ratio		0.29			0.52			0.15			0.32	
Uniform Delay, d1		3.6			4.5			18.0			18.5	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.1			0.2			0.3			0.7	
Delay (s)		3.7			4.7			18.3			19.3	
Level of Service		A			A			B			B	
Approach Delay (s)		3.7			4.7			18.3			19.3	
Approach LOS		A			A			B			B	

Intersection Summary			
HCM Average Control Delay	5.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	50.2	Sum of lost time (s)	9.0
Intersection Capacity Utilization	66.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

4: US 56 & Mulberry

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	660	5	20	1120	30	10	5	20	40	10	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			1.00			0.92			0.98	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3436			3526			1678			1797	
Flt Permitted		0.93			0.94			0.89			0.78	
Satd. Flow (perm)		3213			3313			1509			1444	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	11	710	5	22	1204	32	11	5	22	43	11	11
RTOR Reduction (vph)	0	1	0	0	2	0	0	20	0	0	10	0
Lane Group Flow (vph)	0	725	0	0	1256	0	0	18	0	0	55	0
Heavy Vehicles (%)	0%	5%	0%	0%	2%	0%	0%	0%	5%	0%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		35.8			35.8			5.0			5.0	
Effective Green, g (s)		35.8			35.8			5.0			5.0	
Actuated g/C Ratio		0.72			0.72			0.10			0.10	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2310			2382			152			145	
v/s Ratio Prot												
v/s Ratio Perm		0.23			c0.38			0.01			c0.04	
v/c Ratio		0.31			0.53			0.12			0.38	
Uniform Delay, d1		2.5			3.2			20.4			21.0	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.1			0.2			0.4			1.7	
Delay (s)		2.6			3.4			20.8			22.6	
Level of Service		A			A			C			C	
Approach Delay (s)		2.6			3.4			20.8			22.6	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	4.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	49.8	Sum of lost time (s)	9.0
Intersection Capacity Utilization	60.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

2010 Gardner No Action - PM Peak Hour - Synchro Intersection LOS

5: US 56 & Moonlight Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	110	400	220	170	930	520	130	160	50	250	210	90
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1752	3585	1583	1770	3539	1583	1770	3539	1583	3433	3539	1583
Flt Permitted	0.17	1.00	1.00	0.46	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	322	3585	1583	855	3539	1583	1770	3539	1583	3433	3539	1583
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	121	440	242	187	1022	571	143	176	55	275	231	99
RTOR Reduction (vph)	0	0	151	0	0	341	0	0	49	0	0	88
Lane Group Flow (vph)	121	440	91	187	1022	230	143	176	6	275	231	11
Heavy Vehicles (%)	3%	6%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		Perm
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			4
Actuated Green, G (s)	33.1	28.3	28.3	36.9	30.2	30.2	8.7	8.7	8.7	8.3	8.3	8.3
Effective Green, g (s)	33.1	28.3	28.3	36.9	30.2	30.2	8.7	8.7	8.7	8.3	8.3	8.3
Actuated g/C Ratio	0.44	0.38	0.38	0.49	0.40	0.40	0.12	0.12	0.12	0.11	0.11	0.11
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	234	1353	597	502	1425	637	205	411	184	380	392	175
v/s Ratio Prot	0.03	0.12		c0.03	c0.29		c0.08	0.05		0.08	c0.07	
v/s Ratio Perm	0.20		0.06	0.15		0.15			0.00			0.01
v/c Ratio	0.52	0.33	0.15	0.37	0.72	0.36	0.70	0.43	0.03	0.72	0.59	0.06
Uniform Delay, d1	13.6	16.6	15.4	10.9	18.8	15.7	31.9	30.8	29.4	32.2	31.7	29.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.08	0.91	0.76	1.00	1.00	1.00
Incremental Delay, d2	0.8	0.6	0.5	0.2	3.1	1.6	8.0	0.3	0.0	5.7	1.5	0.1
Delay (s)	14.4	17.2	16.0	11.0	21.9	17.2	42.4	28.4	22.3	37.9	33.2	29.9
Level of Service	B	B	B	B	C	B	D	C	C	D	C	C
Approach Delay (s)		16.4			19.3			32.9			34.8	
Approach LOS		B			B			C			C	

Intersection Summary			
HCM Average Control Delay	22.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	16.5
Intersection Capacity Utilization	64.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

6: Old US 56 & US 56

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Volume (veh/h)	110	20	600	100	10	1520
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	113	21	619	103	10	1567
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1423	309			619	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1423	309			619	
tC, single (s)	6.9	7.0			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.4			2.2	
p0 queue free %	8	97			99	
cM capacity (veh/h)	123	678			971	

Direction, Lane #	NW 1	NW 2	NE 1	NE 2	NE 3	SW 1	SW 2	SW 3
Volume Total	113	21	309	309	103	10	784	784
Volume Left	113	0	0	0	0	10	0	0
Volume Right	0	21	0	0	103	0	0	0
cSH	123	678	1700	1700	1700	971	1700	1700
Volume to Capacity	0.92	0.03	0.18	0.18	0.06	0.01	0.46	0.46
Queue Length 95th (ft)	148	2	0	0	0	1	0	0
Control Delay (s)	127.7	10.5	0.0	0.0	0.0	8.7	0.0	0.0
Lane LOS	F	B				A		
Approach Delay (s)	109.6		0.0			0.1		
Approach LOS	F							

Intersection Summary			
Average Delay	6.1		
Intersection Capacity Utilization	52.7%	ICU Level of Service	A
Analysis Period (min)	15		

7: US-56 & Cedar Niles

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	1140	160	450	1180	30	120	10	350	30	10	20
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00		1.00	0.88	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85	1.00	0.90	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1805	3689	1599	3502	3689	1615		1816	2842	1805	1710	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.72	1.00	0.66	1.00	
Satd. Flow (perm)	1805	3689	1599	3502	3689	1615		1364	2842	1254	1710	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	45	1281	180	506	1326	34	135	11	393	34	11	22
RTOR Reduction (vph)	0	0	101	0	0	14	0	0	0	0	18	0
Lane Group Flow (vph)	45	1281	79	506	1326	20	0	146	393	34	15	0
Heavy Vehicles (%)	0%	3%	1%	0%	3%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Prot		Perm	Prot		Perm	Perm		Perm	Perm		
Protected Phases	5	2		1	6			8			4	
Permitted Phases			2			6	8		8	4		
Actuated Green, G (s)	4.5	33.0	33.0	11.3	39.8	39.8		14.9	14.9	14.9	14.9	
Effective Green, g (s)	4.5	33.0	33.0	11.3	39.8	39.8		14.9	14.9	14.9	14.9	
Actuated g/C Ratio	0.06	0.44	0.44	0.15	0.53	0.53		0.20	0.20	0.20	0.20	
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0	
Lane Grp Cap (vph)	109	1628	705	529	1963	859		272	566	250	341	
v/s Ratio Prot	0.02	c0.35		c0.14	0.36						0.01	
v/s Ratio Perm			0.05			0.01		0.11	c0.14	0.03		
v/c Ratio	0.41	0.79	0.11	0.96	0.68	0.02		0.54	0.69	0.14	0.05	
Uniform Delay, d1	33.9	17.9	12.3	31.5	12.8	8.3		26.9	27.8	24.7	24.2	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.9	2.4	0.0	28.0	0.7	0.0		1.0	3.0	0.1	0.0	
Delay (s)	34.8	20.3	12.3	59.5	13.5	8.3		27.9	30.8	24.7	24.2	
Level of Service	C	C	B	E	B	A		C	C	C	C	
Approach Delay (s)		19.8			25.9			30.0			24.5	
Approach LOS		B			C			C			C	

Intersection Summary			
HCM Average Control Delay	24.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	74.8	Sum of lost time (s)	15.6
Intersection Capacity Utilization	69.6%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

8: US-56 & I-35 SB Ramps

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	1320	210	100	460	0	0	0	0	120	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	0	1389	221	105	484	0	0	0	0	126	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		986										
pX, platoon unblocked				0.69			0.69	0.69	0.69	0.69	0.69	
vC, conflicting volume	484			1611			1953	2195	805	1389	2305	242
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	484			987			1483	1834	0	667	1994	242
tC, single (s)	4.1			4.2			7.5	6.5	6.9	7.5	6.5	7.0
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			77			100	100	100	36	100	100
cM capacity (veh/h)	1089			468			50	41	753	197	33	756

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	SB 1	SB 2
Volume Total	926	684	105	242	242	126	0
Volume Left	0	0	105	0	0	126	0
Volume Right	0	221	0	0	0	0	0
cSH	1700	1700	468	1700	1700	197	1700
Volume to Capacity	0.54	0.40	0.23	0.14	0.14	0.64	0.00
Queue Length 95th (ft)	0	0	21	0	0	94	0
Control Delay (s)	0.0	0.0	14.9	0.0	0.0	51.4	0.0
Lane LOS			B			F	A
Approach Delay (s)	0.0		2.7			51.4	
Approach LOS						F	

Intersection Summary			
Average Delay	3.5		
Intersection Capacity Utilization	65.4%	ICU Level of Service	C
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Gardner

9: US-56 & I-35 NB Ramps

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	460	0	0	490	20	80	0	40	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	0	523	0	0	557	23	91	0	45	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	580			523			1091	1102	261	875	1091	568
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	580			523			1091	1102	261	875	1091	568
tC, single (s)	4.1			4.1			7.6	6.5	7.2	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.6	4.0	3.4	3.5	4.0	3.3
p0 queue free %	100			100			45	100	94	100	100	100
cM capacity (veh/h)	1004			1054			164	213	705	231	217	471

Direction, Lane #	EB 1	EB 2	WB 1	NB 1
Volume Total	261	261	580	136
Volume Left	0	0	0	91
Volume Right	0	0	23	45
cSH	1700	1700	1700	221
Volume to Capacity	0.15	0.15	0.34	0.62
Queue Length 95th (ft)	0	0	0	90
Control Delay (s)	0.0	0.0	0.0	44.6
Lane LOS				E
Approach Delay (s)	0.0		0.0	44.6
Approach LOS				E

Intersection Summary			
Average Delay	4.9		
Intersection Capacity Utilization	64.0%	ICU Level of Service	C
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Gardner

10: Sante Fe & Moonlight Road

PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	90	110	240	60	140	460
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.97		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3432		1770	3539
Flt Permitted	0.95	1.00	1.00		0.56	1.00
Satd. Flow (perm)	1770	1583	3432		1036	3539
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	97	118	258	65	151	495
RTOR Reduction (vph)	0	105	16	0	0	0
Lane Group Flow (vph)	97	13	307	0	151	495
Turn Type		Perm			Perm	
Protected Phases	6		8			4
Permitted Phases		6			4	
Actuated Green, G (s)	8.3	8.3	56.7		56.7	56.7
Effective Green, g (s)	8.3	8.3	56.7		56.7	56.7
Actuated g/C Ratio	0.11	0.11	0.76		0.76	0.76
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	196	175	2595		783	2675
v/s Ratio Prot	c0.05		0.09			0.14
v/s Ratio Perm		0.01			c0.15	
v/c Ratio	0.49	0.07	0.12		0.19	0.19
Uniform Delay, d1	31.4	29.9	2.5		2.6	2.6
Progression Factor	1.00	1.00	1.00		0.82	0.83
Incremental Delay, d2	2.0	0.2	0.1		0.5	0.1
Delay (s)	33.3	30.1	2.5		2.6	2.3
Level of Service	C	C	A		A	A
Approach Delay (s)	31.6		2.5			2.4
Approach LOS	C		A			A

Intersection Summary			
HCM Average Control Delay	7.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.23		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	34.6%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

BNSF NEPA Traffic Study — 2010 No-Action Gardner

11: Waverly Road & US 56

PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	10	5	10	5	10	20	120	0	5	260	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	13	6	13	6	13	25	152	0	6	329	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	563	551	152	560	547	332	335			152		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	563	551	152	560	547	332	335			152		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.3	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.4	2.2			2.2		
p0 queue free %	100	97	99	97	99	98	98			100		
cM capacity (veh/h)	419	434	900	407	436	691	1235			1441		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	19	32	177	342
Volume Left	0	13	25	6
Volume Right	6	13	0	6
cSH	525	495	1235	1441
Volume to Capacity	0.04	0.06	0.02	0.00
Queue Length 95th (ft)	3	5	2	0
Control Delay (s)	12.1	12.8	1.3	0.2
Lane LOS	B	B	A	A
Approach Delay (s)	12.1	12.8	1.3	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	32.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Gardner

12: 183rd Street & Four Corners Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	5	5	0	5	5	5	5	0	5	5	5
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	5	0	5	5	5	5	0	5	5	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	16	11	11	16
Volume Left (vph)	5	0	5	5
Volume Right (vph)	5	5	0	5
Hadj (s)	-0.13	-0.30	0.10	-0.13
Departure Headway (s)	3.8	3.7	4.1	3.8
Degree Utilization, x	0.02	0.01	0.01	0.02
Capacity (veh/h)	925	967	865	927
Control Delay (s)	6.9	6.7	7.1	6.9
Approach Delay (s)	6.9	6.7	7.1	6.9
Approach LOS	A	A	A	A

Intersection Summary			
Delay	6.9		
HCM Level of Service	A		
Intersection Capacity Utilization	15.2%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Gardner No Action - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 No-Action Gardner

13: 183rd Street & US 56

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✣			✣			✣			✣	
Volume (veh/h)	5	5	0	10	10	0	0	140	10	0	270	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	6	0	13	13	0	0	177	13	0	342	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	532	532	342	528	525	184	342			190		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	532	532	342	528	525	184	342			190		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	99	100	97	97	100	100			100		
cM capacity (veh/h)	452	456	705	459	460	864	1229			1396		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	13	25	190	342
Volume Left	6	13	0	0
Volume Right	0	0	13	0
cSH	454	460	1229	1396
Volume to Capacity	0.03	0.06	0.00	0.00
Queue Length 95th (ft)	2	4	0	0
Control Delay (s)	13.2	13.3	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	13.2	13.3	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	24.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Gardner

14: 183rd Street & Waverly Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✣			✣			✣			✣	
Volume (veh/h)	0	20	5	5	10	10	5	5	5	5	5	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	22	5	5	11	11	5	5	5	5	5	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	22			27			60	57	24	60	54	16
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	22			27			60	57	24	60	54	16
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			99	99	99	99	99	99
cM capacity (veh/h)	1607			1600			929	835	1058	929	838	1069

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	27	27	16	16
Volume Left	0	5	5	5
Volume Right	5	11	5	5
cSH	1607	1600	932	936
Volume to Capacity	0.00	0.00	0.02	0.02
Queue Length 95th (ft)	0	0	1	1
Control Delay (s)	0.0	1.5	8.9	8.9
Lane LOS		A	A	A
Approach Delay (s)	0.0	1.5	8.9	8.9
Approach LOS			A	A

Intersection Summary			
Average Delay	3.8		
Intersection Capacity Utilization	15.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Gardner

15: 183rd Street & Gardner Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Volume (veh/h)	30	20	30	50	30	40	70	270	110	60	240	40
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	34	22	34	56	34	45	79	303	124	67	270	45
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	798	1011	157	837	972	213	315			427		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	798	1011	157	837	972	213	315			427		
tC, single (s)	7.6	6.5	7.0	7.5	6.6	7.0	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	84	89	96	73	85	94	94			94		
cM capacity (veh/h)	209	213	857	209	220	788	1250			1129		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	34	56	56	79	79	202	225	67	180	135
Volume Left	34	0	56	0	79	0	0	67	0	0
Volume Right	0	34	0	45	0	0	124	0	0	45
cSH	209	387	209	374	1250	1700	1700	1129	1700	1700
Volume to Capacity	0.16	0.15	0.27	0.21	0.06	0.12	0.13	0.06	0.11	0.08
Queue Length 95th (ft)	14	13	26	20	5	0	0	5	0	0
Control Delay (s)	25.5	15.9	28.5	17.2	8.1	0.0	0.0	8.4	0.0	0.0
Lane LOS	D	C	D	C	A			A		
Approach Delay (s)	19.5		21.9		1.3			1.5		
Approach LOS	C		C							

Intersection Summary			
Average Delay	5.3		
Intersection Capacity Utilization	33.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Gardner

16: Four Corners Road & US 56

PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✣			✣			✣			✣	
Volume (veh/h)	5	5	5	0	5	5	5	150	5	5	280	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	7	7	7	0	7	7	7	197	7	7	368	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	605	595	201	605	599	368	368			204		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	605	595	201	605	599	368	368			204		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	100	98	99	99			100		
cM capacity (veh/h)	400	416	845	401	414	682	1201			1380		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	20	13	211	375
Volume Left	7	0	7	7
Volume Right	7	7	7	0
cSH	493	515	1201	1380
Volume to Capacity	0.04	0.03	0.01	0.00
Queue Length 95th (ft)	3	2	0	0
Control Delay (s)	12.6	12.2	0.3	0.2
Lane LOS	B	B	A	A
Approach Delay (s)	12.6	12.2	0.3	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	28.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Gardner

17: 191st Street & US 56 — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	0	0	5	5	0	0	150	0	0	280	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	0	0	0	6	6	0	0	195	0	0	364	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	565	562	367	562	565	195	370			195		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	565	562	367	562	565	195	370			195		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	99	99	100	100			100		
cM capacity (veh/h)	434	439	683	441	437	852	1199			1390		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	0	13	195	370
Volume Left	0	6	0	0
Volume Right	0	0	0	6
cSH	1700	439	1199	1390
Volume to Capacity	0.00	0.03	0.00	0.00
Queue Length 95th (ft)	0	2	0	0
Control Delay (s)	0.0	13.5	0.0	0.0
Lane LOS	A	B		
Approach Delay (s)	0.0	13.5	0.0	0.0
Approach LOS	A	B		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	25.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Gardner

18: 191st Street & Four Corners Road — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	10	10	10	5	5	5
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	11	11	5	5	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	30	14			16	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	30	14			16	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	99			100	
cM capacity (veh/h)	986	1072			1614	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	22	16	11
Volume Left	11	0	5
Volume Right	11	5	0
cSH	1027	1700	1614
Volume to Capacity	0.02	0.01	0.00
Queue Length 95th (ft)	2	0	0
Control Delay (s)	8.6	0.0	3.6
Lane LOS	A		A
Approach Delay (s)	8.6	0.0	3.6
Approach LOS	A		

Intersection Summary			
Average Delay	4.6		
Intersection Capacity Utilization	14.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Gardner

19: 191st Street & Waverly Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	5	0	5	10	10	5	5	5	5	5	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	0	5	11	11	5	5	5	5	5	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	22			5			52	49	5	52	43	16
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	22			5			52	49	5	52	43	16
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			99	99	99	99	99	99
cM capacity (veh/h)	1607			1629			938	841	1083	938	847	1069

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	11	27	16	16
Volume Left	5	5	5	5
Volume Right	0	11	5	5
cSH	1607	1629	944	943
Volume to Capacity	0.00	0.00	0.02	0.02
Queue Length 95th (ft)	0	0	1	1
Control Delay (s)	3.6	1.5	8.9	8.9
Lane LOS	A	A	A	A
Approach Delay (s)	3.6	1.5	8.9	8.9
Approach LOS			A	A

Intersection Summary			
Average Delay	5.2		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Gardner

20: W 191st Street & Gardner Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	5	30	20	5	20	20	510	20	20	380	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	2.5	2.5	2.5		2.5			2.5			2.5	2.5
Lane Util. Factor	1.00	1.00	1.00		1.00			0.95			0.95	1.00
Frt	1.00	1.00	0.85		0.94			0.99			1.00	0.85
Flt Protected	0.95	1.00	1.00		0.98			1.00			1.00	1.00
Satd. Flow (prot)	1805	1900	1468		1746			3419			3501	1468
Flt Permitted	0.80	1.00	1.00		0.86			0.94			0.92	1.00
Satd. Flow (perm)	1520	1900	1468		1537			3202			3222	1468
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	11	5	32	22	5	22	21	537	22	22	400	11
RTOR Reduction (vph)	0	0	30	0	21	0	0	1	0	0	0	1
Lane Group Flow (vph)	11	5	2	0	28	0	0	579	0	0	422	10
Heavy Vehicles (%)	0%	0%	10%	0%	0%	0%	5%	5%	0%	0%	3%	10%
Turn Type	Perm		Perm	Perm			Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	5.0	5.0	5.0		5.0			80.0			80.0	80.0
Effective Green, g (s)	5.0	5.0	5.0		5.0			80.0			80.0	80.0
Actuated g/C Ratio	0.06	0.06	0.06		0.06			0.89			0.89	0.89
Clearance Time (s)	2.5	2.5	2.5		2.5			2.5			2.5	2.5
Vehicle Extension (s)	3.0	3.0	3.0		3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	84	106	82		85			2846			2864	1305
v/s Ratio Prot		0.00										
v/s Ratio Perm	0.01		0.00		c0.02			c0.18			0.13	0.01
v/c Ratio	0.13	0.05	0.02		0.33			0.20			0.15	0.01
Uniform Delay, d1	40.4	40.2	40.2		40.9			0.7			0.6	0.6
Progression Factor	1.00	1.00	1.00		1.00			0.78			1.00	1.00
Incremental Delay, d2	0.7	0.2	0.1		2.3			0.2			0.1	0.0
Delay (s)	41.1	40.4	40.3		43.2			0.7			0.7	0.6
Level of Service	D	D	D		D			A			A	A
Approach Delay (s)		40.5			43.2			0.7			0.7	
Approach LOS		D			D			A			A	

Intersection Summary			
HCM Average Control Delay	4.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.21		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	5.0
Intersection Capacity Utilization	45.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

2010 Gardner No Action - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 No-Action Gardner

21: I-35 SB Ramps & Gardner Rd

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	150	0	390	10	150	0	0	350	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				2.5		2.5		2.5			2.5	2.5
Lane Util. Factor				1.00		1.00		1.00			1.00	1.00
Frt				1.00		0.85		1.00			1.00	0.85
Flt Protected				0.95		1.00		1.00			1.00	1.00
Satd. Flow (prot)				1752		1538		1831			1845	1538
Flt Permitted				0.95		1.00		0.98			1.00	1.00
Satd. Flow (perm)				1752		1538		1797			1845	1538
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	160	0	415	11	160	0	0	372	85
RTOR Reduction (vph)	0	0	0	0	0	350	0	0	0	0	0	18
Lane Group Flow (vph)	0	0	0	160	0	65	0	171	0	0	372	67
Heavy Vehicles (%)	0%	0%	0%	3%	0%	5%	10%	3%	0%	0%	3%	5%
Turn Type				Prot		custom	Perm					Perm
Protected Phases				3				2			6	
Permitted Phases						3	2					6
Actuated Green, G (s)				14.2		14.2		70.8			70.8	70.8
Effective Green, g (s)				14.2		14.2		70.8			70.8	70.8
Actuated g/C Ratio				0.16		0.16		0.79			0.79	0.79
Clearance Time (s)				2.5		2.5		2.5			2.5	2.5
Vehicle Extension (s)				3.0		3.0		3.0			3.0	3.0
Lane Grp Cap (vph)				276		243		1414			1451	1210
v/s Ratio Prot				c0.09							c0.20	
v/s Ratio Perm						0.04		0.10				0.04
v/c Ratio				0.58		0.27		0.12			0.26	0.06
Uniform Delay, d1				35.1		33.3		2.3			2.6	2.1
Progression Factor				1.00		1.00		1.55			0.92	0.82
Incremental Delay, d2				2.9		0.6		0.2			0.4	0.1
Delay (s)				38.1		33.9		3.7			2.8	1.8
Level of Service				D		C		A			A	A
Approach Delay (s)		0.0			35.1			3.7			2.6	
Approach LOS		A			D			A			A	

Intersection Summary			
HCM Average Control Delay	18.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.31		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	5.0
Intersection Capacity Utilization	39.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 No-Action Gardner

22: I-35 NB Ramps & Gardner Rd

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	0	20	0	0	0	0	120	40	210	280	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		2.5						2.5			2.5	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.96						0.97			1.00	
Flt Protected		0.97						1.00			0.98	
Satd. Flow (prot)		1641						1774			1796	
Flt Permitted		0.97						1.00			0.79	
Satd. Flow (perm)		1641						1774			1449	
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	44	0	22	0	0	0	0	132	44	231	308	0
RTOR Reduction (vph)	0	20	0	0	0	0	0	6	0	0	0	0
Lane Group Flow (vph)	0	46	0	0	0	0	0	170	0	0	539	0
Heavy Vehicles (%)	8%	0%	5%	0%	0%	0%	0%	3%	5%	7%	1%	0%
Turn Type	Perm									Perm		
Protected Phases		4						2			6	
Permitted Phases	4									6		
Actuated Green, G (s)		7.0						78.0			78.0	
Effective Green, g (s)		7.0						78.0			78.0	
Actuated g/C Ratio		0.08						0.87			0.87	
Clearance Time (s)		2.5						2.5			2.5	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		128						1537			1256	
v/s Ratio Prot								0.10				
v/s Ratio Perm		0.03									c0.37	
v/c Ratio		0.36						0.11			0.43	
Uniform Delay, d1		39.4						0.9			1.3	
Progression Factor		1.00						1.00			0.75	
Incremental Delay, d2		1.7						0.1			1.1	
Delay (s)		41.1						1.0			2.0	
Level of Service		D						A			A	
Approach Delay (s)		41.1			0.0			1.0			2.0	
Approach LOS		D			A			A			A	

Intersection Summary			
HCM Average Control Delay	5.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	5.0
Intersection Capacity Utilization	48.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 No-Action Gardner

23: E 191st Street & Gardner Rd

PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	5	150	5	10	290
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	5	161	5	11	312
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						220
pX, platoon unblocked						
vC, conflicting volume	497	164			167	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	497	164			167	
tC, single (s)	6.4	6.4			4.2	
tC, 2 stage (s)						
tF (s)	3.5	3.5			2.3	
p0 queue free %	100	99			99	
cM capacity (veh/h)	532	836			1364	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	5	167	323
Volume Left	0	0	11
Volume Right	5	5	0
cSH	836	1700	1364
Volume to Capacity	0.01	0.10	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	9.3	0.0	0.3
Lane LOS	A		A
Approach Delay (s)	9.3	0.0	0.3
Approach LOS	A		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	33.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Gardner

24: Sunflower Road & US 56

PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	5	10	30	5	0	10	150	30	0	290	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	6	13	38	6	0	13	190	38	0	367	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	608	623	370	620	608	209	373			228		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	608	623	370	620	608	209	373			228		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	98	98	90	98	100	99			100		
cM capacity (veh/h)	403	400	680	383	409	837	1196			1352		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	19	44	241	373
Volume Left	0	38	13	0
Volume Right	13	0	38	6
cSH	552	387	1196	1352
Volume to Capacity	0.03	0.11	0.01	0.00
Queue Length 95th (ft)	3	10	1	0
Control Delay (s)	11.8	15.5	0.5	0.0
Lane LOS	B	C	A	
Approach Delay (s)	11.8	15.5	0.5	0.0
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	33.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2010 No-Action Gardner
25: US 56 & 4th Street | PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	170	20	30	310	60	20
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	218	26	38	397	77	26
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			244		705	231
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			244		705	231
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		80	97
cM capacity (veh/h)			1335		391	813

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	244	436	103
Volume Left	0	38	77
Volume Right	26	0	26
cSH	1700	1335	449
Volume to Capacity	0.14	0.03	0.23
Queue Length 95th (ft)	0	2	22
Control Delay (s)	0.0	1.0	15.4
Lane LOS		A	C
Approach Delay (s)	0.0	1.0	15.4
Approach LOS			C

Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	42.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2010 No-Action Gardner
26: 199th Street & Four Corners Road | PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	30	40	5	10	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	6	36	48	6	12	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	54				98	51
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	54				98	51
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	99
cM capacity (veh/h)	1565				902	1023

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	42	54	18
Volume Left	6	0	12
Volume Right	0	6	6
cSH	1565	1700	939
Volume to Capacity	0.00	0.03	0.02
Queue Length 95th (ft)	0	0	1
Control Delay (s)	1.1	0.0	8.9
Lane LOS	A		A
Approach Delay (s)	1.1	0.0	8.9
Approach LOS			A

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	15.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2010 No-Action Gardner
27: 199th Street & Gardner Road | PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	20	20	10	30	30	10	80	10	30	170	40
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	22	22	22	11	34	34	11	90	11	34	191	45

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	67	79	112	270
Volume Left (vph)	22	11	11	34
Volume Right (vph)	22	34	11	45
Hadj (s)	-0.13	-0.18	0.01	-0.04
Departure Headway (s)	4.7	4.7	4.6	4.4
Degree Utilization, x	0.09	0.10	0.14	0.33
Capacity (veh/h)	690	701	747	792
Control Delay (s)	8.2	8.2	8.3	9.5
Approach Delay (s)	8.2	8.2	8.3	9.5
Approach LOS	A	A	A	A

Intersection Summary			
Delay	8.9		
HCM Level of Service	A		
Intersection Capacity Utilization	31.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2010 No-Action Gardner
30: US-56 & I-35 NB Loop | PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	460	980	0	560	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	517	1101	0	629	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			1618		831	258
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1618		831	258
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			408		312	747

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	258	258	1101	315	315
Volume Left	0	0	0	0	0
Volume Right	0	0	1101	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.15	0.15	0.65	0.19	0.19
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	64.0%	ICU Level of Service	C
Analysis Period (min)	15		

2010 Gardner No Action - (Improved) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

1: 175th Street & Waverly Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	90	5	5	280	80	10	20	5	30	20	20
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	12	108	6	6	337	96	12	24	6	36	24	24
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	434			114			569	581	111	551	536	386
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	434			114			569	581	111	551	536	386
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			100			97	94	99	91	95	96
cM capacity (veh/h)	1137			1487			398	421	947	417	447	667

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	127	440	42	84
Volume Left	12	6	12	36
Volume Right	6	96	6	24
cSH	1137	1487	450	477
Volume to Capacity	0.01	0.00	0.09	0.18
Queue Length 95th (ft)	1	0	8	16
Control Delay (s)	0.9	0.1	13.8	14.2
Lane LOS	A	A	B	B
Approach Delay (s)	0.9	0.1	13.8	14.2
Approach LOS			B	B

Intersection Summary			
Average Delay	2.8		
Intersection Capacity Utilization	33.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

2: US 56 & Gardner Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	270	50	210	630	220	60	150	140	140	150	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.98			0.97		1.00	0.93		1.00	0.97	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3301			3389		1770	1694		1736	1773	
Flt Permitted		0.86			0.77		0.62	1.00		0.44	1.00	
Satd. Flow (perm)		2837			2650		1158	1694		813	1773	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	23	310	57	241	724	253	69	172	161	161	172	46
RTOR Reduction (vph)	0	22	0	0	38	0	0	60	0	0	17	0
Lane Group Flow (vph)	0	368	0	0	1180	0	69	273	0	161	201	0
Heavy Vehicles (%)	0%	8%	2%	1%	3%	1%	2%	4%	4%	4%	4%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		27.6			27.6		15.2	15.2		15.2	15.2	
Effective Green, g (s)		27.6			27.6		15.2	15.2		15.2	15.2	
Actuated g/C Ratio		0.51			0.51		0.28	0.28		0.28	0.28	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1437			1342		323	472		227	494	
v/s Ratio Prot								0.16			0.11	
v/s Ratio Perm		0.13			c0.45		0.06			c0.20		
v/c Ratio		0.26			0.88		0.21	0.58		0.71	0.41	
Uniform Delay, d1		7.6			12.0		15.1	16.9		17.7	16.0	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.1			6.9		0.3	1.7		9.7	0.5	
Delay (s)		7.7			18.9		15.4	18.6		27.4	16.5	
Level of Service		A			B		B	B		C	B	
Approach Delay (s)		7.7			18.9			18.1			21.1	
Approach LOS		A			B			B			C	

Intersection Summary			
HCM Average Control Delay	17.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	54.5	Sum of lost time (s)	11.7
Intersection Capacity Utilization	84.5%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

3: US 56 & Elm

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	560	20	30	1030	40	20	10	40	60	10	30
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		0.99			0.99			0.92			0.96	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3574			3702			1765			1842	
Flt Permitted		0.93			0.93			0.90			0.81	
Satd. Flow (perm)		3337			3444			1606			1544	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	11	602	22	32	1108	43	22	11	43	65	11	32
RTOR Reduction (vph)	0	2	0	0	3	0	0	36	0	0	27	0
Lane Group Flow (vph)	0	633	0	0	1180	0	0	40	0	0	81	0
Heavy Vehicles (%)	0%	6%	0%	3%	2%	0%	5%	0%	3%	2%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		33.0			33.0			8.2			8.2	
Effective Green, g (s)		33.0			33.0			8.2			8.2	
Actuated g/C Ratio		0.66			0.66			0.16			0.16	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2194			2264			262			252	
v/s Ratio Prot												
v/s Ratio Perm		0.19			c0.34			0.02			c0.05	
v/c Ratio		0.29			0.52			0.15			0.32	
Uniform Delay, d1		3.6			4.5			18.0			18.5	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.1			0.2			0.3			0.7	
Delay (s)		3.7			4.7			18.3			19.3	
Level of Service		A			A			B			B	
Approach Delay (s)		3.7			4.7			18.3			19.3	
Approach LOS		A			A			B			B	

Intersection Summary			
HCM Average Control Delay	5.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	50.2	Sum of lost time (s)	9.0
Intersection Capacity Utilization	66.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

4: US 56 & Mulberry

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	660	5	20	1120	30	10	5	20	40	10	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			1.00			0.92			0.98	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3436			3526			1678			1797	
Flt Permitted		0.93			0.94			0.89			0.78	
Satd. Flow (perm)		3213			3313			1509			1444	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	11	710	5	22	1204	32	11	5	22	43	11	11
RTOR Reduction (vph)	0	1	0	0	2	0	0	20	0	0	10	0
Lane Group Flow (vph)	0	725	0	0	1256	0	0	18	0	0	55	0
Heavy Vehicles (%)	0%	5%	0%	0%	2%	0%	0%	0%	5%	0%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		35.8			35.8			5.0			5.0	
Effective Green, g (s)		35.8			35.8			5.0			5.0	
Actuated g/C Ratio		0.72			0.72			0.10			0.10	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2310			2382			152			145	
v/s Ratio Prot												
v/s Ratio Perm		0.23			c0.38			0.01			c0.04	
v/c Ratio		0.31			0.53			0.12			0.38	
Uniform Delay, d1		2.5			3.2			20.4			21.0	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.1			0.2			0.4			1.7	
Delay (s)		2.6			3.4			20.8			22.6	
Level of Service		A			A			C			C	
Approach Delay (s)		2.6			3.4			20.8			22.6	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	4.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	49.8	Sum of lost time (s)	9.0
Intersection Capacity Utilization	60.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)
5: US 56 & Moonlight Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	110	400	220	170	930	520	130	160	50	250	210	90
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1752	3585	1583	1770	3539	1583	1770	3539	1583	3433	3539	1583
Flt Permitted	0.17	1.00	1.00	0.48	1.00	1.00	0.61	1.00	1.00	0.57	1.00	1.00
Satd. Flow (perm)	321	3585	1583	896	3539	1583	1132	3539	1583	2046	3539	1583
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	121	440	242	187	1022	571	143	176	55	275	231	99
RTOR Reduction (vph)	0	0	147	0	0	300	0	0	48	0	0	84
Lane Group Flow (vph)	121	440	95	187	1022	271	143	176	7	275	231	15
Heavy Vehicles (%)	3%	6%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6	8		8	4		4
Actuated Green, G (s)	31.0	27.4	27.4	32.8	28.3	28.3	13.9	9.1	9.1	16.3	10.3	10.3
Effective Green, g (s)	31.0	27.4	27.4	32.8	28.3	28.3	13.9	9.1	9.1	16.3	10.3	10.3
Actuated g/C Ratio	0.44	0.39	0.39	0.47	0.40	0.40	0.20	0.13	0.13	0.23	0.15	0.15
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	216	1403	620	476	1431	640	269	460	206	595	521	233
v/s Ratio Prot	c0.03	0.12		0.03	c0.29		0.04	0.05		c0.04	0.07	
v/s Ratio Perm	0.22		0.06	0.16		0.17	c0.07		0.00	0.07		0.01
v/c Ratio	0.56	0.31	0.15	0.39	0.71	0.42	0.53	0.38	0.03	0.46	0.44	0.06
Uniform Delay, d1	12.7	14.8	13.8	11.1	17.5	15.0	24.5	27.9	26.6	22.4	27.2	25.7
Progression Factor	1.00	1.00	1.00	0.65	0.67	0.62	0.89	0.91	0.76	1.00	1.00	1.00
Incremental Delay, d2	2.0	0.6	0.5	0.2	2.7	1.8	1.0	0.2	0.0	0.2	0.2	0.0
Delay (s)	14.6	15.4	14.3	7.3	14.4	11.1	22.9	25.7	20.2	22.6	27.5	25.7
Level of Service	B	B	B	A	B	B	C	C	C	C	C	C
Approach Delay (s)		14.9			12.6			23.8			25.0	
Approach LOS		B			B			C			C	

Intersection Summary			
HCM Average Control Delay	16.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	16.5
Intersection Capacity Utilization	64.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)
6: Old US 56 & US 56 — PM Peak Hour

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	110	20	600	100	10	1520
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	4.0	5.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1736	1538	3619	1553	1805	3725
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1736	1538	3619	1553	1805	3725
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	113	21	619	103	10	1567
RTOR Reduction (vph)	0	19	0	91	0	0
Lane Group Flow (vph)	113	2	619	12	10	1567
Heavy Vehicles (%)	4%	5%	5%	4%	0%	2%
Turn Type		Perm		custom	Prot	
Protected Phases	8		2	4	1	6
Permitted Phases		8				
Actuated Green, G (s)	8.3	8.3	47.1	8.3	0.6	51.7
Effective Green, g (s)	8.3	8.3	47.1	8.3	0.6	51.7
Actuated g/C Ratio	0.12	0.12	0.67	0.12	0.01	0.74
Clearance Time (s)	5.0	5.0	5.0	5.0	4.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	206	182	2435	184	15	2751
v/s Ratio Prot	c0.07		0.17	0.01	0.01	c0.42
v/s Ratio Perm		0.00				
v/c Ratio	0.55	0.01	0.25	0.07	0.67	0.57
Uniform Delay, d1	29.1	27.2	4.5	27.4	34.6	4.1
Progression Factor	1.00	1.00	1.12	1.41	1.29	0.31
Incremental Delay, d2	3.0	0.0	0.2	0.1	65.2	0.7
Delay (s)	32.1	27.3	5.3	38.8	109.8	2.0
Level of Service	C	C	A	D	F	A
Approach Delay (s)	31.3		10.1			2.7
Approach LOS	C		A			A

Intersection Summary			
HCM Average Control Delay	6.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	54.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)
7: US-56 & Cedar Niles — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	1140	160	450	1180	30	120	10	350	30	10	20
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00		1.00	0.88	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85	1.00	0.90	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1805	3689	1599	3502	3689	1615		1816	2842	1805	1710	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.72	1.00	0.66	1.00	
Satd. Flow (perm)	1805	3689	1599	3502	3689	1615		1364	2842	1255	1710	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	45	1281	180	506	1326	34	135	11	393	34	11	22
RTOR Reduction (vph)	0	0	97	0	0	15	0	0	0	0	19	0
Lane Group Flow (vph)	45	1281	83	506	1326	19	0	146	393	34	14	0
Heavy Vehicles (%)	0%	3%	1%	0%	3%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Prot		Perm	Prot		Perm	Perm		pt+ov	Perm		
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases			2			6	8			4		
Actuated Green, G (s)	4.8	32.3	32.3	11.6	39.1	39.1		10.5	27.3	10.5	10.5	
Effective Green, g (s)	4.8	32.3	32.3	11.6	39.1	39.1		10.5	27.3	10.5	10.5	
Actuated g/C Ratio	0.07	0.46	0.46	0.17	0.56	0.56		0.15	0.39	0.15	0.15	
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2		5.2	5.2	
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0		1.0		1.0	1.0	
Lane Grp Cap (vph)	124	1702	738	580	2061	902		205	1108	188	257	
v/s Ratio Prot	0.02	c0.35		c0.14	0.36				0.14		0.01	
v/s Ratio Perm			0.05			0.01		c0.11		0.03		
v/c Ratio	0.36	0.75	0.11	0.87	0.64	0.02		0.71	0.35	0.18	0.06	
Uniform Delay, d1	31.1	15.6	10.7	28.5	10.6	6.9		28.3	15.1	26.0	25.5	
Progression Factor	0.97	1.03	1.84	1.03	0.87	0.88		1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.7	3.1	0.3	13.2	1.6	0.0		9.3	0.1	0.2	0.0	
Delay (s)	30.7	19.1	20.1	42.6	10.8	6.1		37.6	15.2	26.2	25.5	
Level of Service	C	B	C	D	B	A		D	B	C	C	
Approach Delay (s)		19.5			19.3			21.3			25.9	
Approach LOS		B			B			C			C	

Intersection Summary			
HCM Average Control Delay	19.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	15.6
Intersection Capacity Utilization	69.6%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)
8: US-56 & I-35 SB Ramps — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1320	210	100	460	0	0	0	0	120	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		4.0	5.0					5.0		
Lane Util. Factor		0.95		1.00	0.95					1.00		
Frt		0.98		1.00	1.00					1.00		
Flt Protected		1.00		0.95	1.00					0.95		
Satd. Flow (prot)		3437		1719	3725					1770		
Flt Permitted		1.00		0.09	1.00					0.95		
Satd. Flow (perm)		3437		160	3725					1770		
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1389	221	105	484	0	0	0	0	126	0	0
RTOR Reduction (vph)	0	14	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	1596	0	105	484	0	0	0	0	126	0	0
Heavy Vehicles (%)	0%	3%	2%	5%	2%	0%	0%	0%	0%	2%	0%	3%
Turn Type	Prot			pm+pt						custom		custom
Protected Phases	5	2		1	6							5
Permitted Phases				6						4		4
Actuated Green, G (s)		41.2		51.1	51.1					8.9		
Effective Green, g (s)		41.2		51.1	51.1					8.9		
Actuated g/C Ratio		0.59		0.73	0.73					0.13		
Clearance Time (s)		5.0		4.0	5.0					5.0		
Vehicle Extension (s)		3.0		3.0	3.0					3.0		
Lane Grp Cap (vph)		2023		248	2719					225		
v/s Ratio Prot		c0.46		c0.04	0.13							
v/s Ratio Perm				0.27						c0.07		
v/c Ratio		0.79		0.42	0.18					0.56		
Uniform Delay, d1		11.1		8.9	2.9					28.7		
Progression Factor		0.67		0.89	1.25					1.00		
Incremental Delay, d2		2.4		1.1	0.1					3.2		
Delay (s)		9.8		9.0	3.8					31.9		
Level of Service		A		A	A					C		
Approach Delay (s)		9.8			4.7			0.0			31.9	
Approach LOS		A			A			A			C	

Intersection Summary			
HCM Average Control Delay	9.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	66.5%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

9: US-56 & I-35 NB Ramps

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	460	0	0	490	20	80	0	40	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			0.99			0.96				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3762			1847			1622				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3762			1847			1622				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	523	0	0	557	23	91	0	45	0	0	0
RTOR Reduction (vph)	0	0	0	0	2	0	0	28	0	0	0	0
Lane Group Flow (vph)	0	523	0	0	578	0	0	108	0	0	0	0
Heavy Vehicles (%)	0%	1%	0%	0%	2%	10%	6%	0%	13%	0%	0%	0%
Turn Type							Perm					
Protected Phases		2			6			8				
Permitted Phases							8					
Actuated Green, G (s)		51.2			51.2			8.8				
Effective Green, g (s)		51.2			51.2			8.8				
Actuated g/C Ratio		0.73			0.73			0.13				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		2752			1351			204				
v/s Ratio Prot		0.14			c0.31							
v/s Ratio Perm								0.07				
v/c Ratio		0.19			0.43			0.53				
Uniform Delay, d1		2.9			3.7			28.7				
Progression Factor		1.11			1.00			1.00				
Incremental Delay, d2		0.1			1.0			2.5				
Delay (s)		3.4			4.7			31.1				
Level of Service		A			A			C				
Approach Delay (s)		3.4			4.7			31.1			0.0	
Approach LOS		A			A			C			A	

Intersection Summary			
HCM Average Control Delay	7.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

10: Sante Fe & Moonlight Road

PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	90	110	240	60	140	460
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.97		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3432		1770	3539
Flt Permitted	0.95	1.00	1.00		0.56	1.00
Satd. Flow (perm)	1770	1583	3432		1036	3539
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	97	118	258	65	151	495
RTOR Reduction (vph)	0	105	17	0	0	0
Lane Group Flow (vph)	97	13	306	0	151	495
Turn Type		Perm			Perm	
Protected Phases	6		8			4
Permitted Phases		6			4	
Actuated Green, G (s)	8.0	8.0	52.0		52.0	52.0
Effective Green, g (s)	8.0	8.0	52.0		52.0	52.0
Actuated g/C Ratio	0.11	0.11	0.74		0.74	0.74
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	202	181	2549		770	2629
v/s Ratio Prot	c0.05		0.09			0.14
v/s Ratio Perm		0.01			c0.15	
v/c Ratio	0.48	0.07	0.12		0.20	0.19
Uniform Delay, d1	29.1	27.7	2.5		2.7	2.7
Progression Factor	1.00	1.00	1.00		0.85	0.83
Incremental Delay, d2	1.8	0.2	0.1		0.5	0.1
Delay (s)	30.8	27.9	2.6		2.9	2.4
Level of Service	C	C	A		A	A
Approach Delay (s)	29.2		2.6			2.5
Approach LOS	C		A			A

Intersection Summary			
HCM Average Control Delay	7.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.23		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	34.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

11: Waverly Road & US 56

PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	10	5	10	5	10	20	120	0	5	260	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	13	6	13	6	13	25	152	0	6	329	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	563	551	152	560	547	332	335			152		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	563	551	152	560	547	332	335			152		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.3	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.4	2.2			2.2		
p0 queue free %	100	97	99	97	99	98	98			100		
cM capacity (veh/h)	419	434	900	407	436	691	1235			1441		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	19	32	177	342
Volume Left	0	13	25	6
Volume Right	6	13	0	6
cSH	525	495	1235	1441
Volume to Capacity	0.04	0.06	0.02	0.00
Queue Length 95th (ft)	3	5	2	0
Control Delay (s)	12.1	12.8	1.3	0.2
Lane LOS	B	B	A	A
Approach Delay (s)	12.1	12.8	1.3	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	32.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

12: 183rd Street & Four Corners Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	5	5	0	5	5	5	5	0	5	5	5
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	5	0	5	5	5	5	0	5	5	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	16	11	11	16
Volume Left (vph)	5	0	5	5
Volume Right (vph)	5	5	0	5
Hadj (s)	-0.13	-0.30	0.10	-0.13
Departure Headway (s)	3.8	3.7	4.1	3.8
Degree Utilization, x	0.02	0.01	0.01	0.02
Capacity (veh/h)	925	967	865	927
Control Delay (s)	6.9	6.7	7.1	6.9
Approach Delay (s)	6.9	6.7	7.1	6.9
Approach LOS	A	A	A	A

Intersection Summary			
Delay	6.9		
HCM Level of Service	A		
Intersection Capacity Utilization	15.2%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Gardner No Action - (Improved) - PM Peak Hour - Synchro Intersection LOS

13: 183rd Street & US 56

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✥			✥			✥			✥	
Volume (veh/h)	5	5	0	10	10	0	0	140	10	0	270	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	6	0	13	13	0	0	177	13	0	342	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	532	532	342	528	525	184	342			190		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	532	532	342	528	525	184	342			190		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	99	100	97	97	100	100			100		
cM capacity (veh/h)	452	456	705	459	460	864	1229			1396		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	13	25	190	342
Volume Left	6	13	0	0
Volume Right	0	0	13	0
cSH	454	460	1229	1396
Volume to Capacity	0.03	0.06	0.00	0.00
Queue Length 95th (ft)	2	4	0	0
Control Delay (s)	13.2	13.3	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	13.2	13.3	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	24.2%	ICU Level of Service	A
Analysis Period (min)	15		

14: 183rd Street & Waverly Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✥			✥			✥			✥	
Volume (veh/h)	0	20	5	5	10	10	5	5	5	5	5	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	22	5	5	11	11	5	5	5	5	5	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	22			27			60	57	24	60	54	16
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	22			27			60	57	24	60	54	16
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			99	99	99	99	99	99
cM capacity (veh/h)	1607			1600			929	835	1058	929	838	1069

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	27	27	16	16
Volume Left	0	5	5	5
Volume Right	5	11	5	5
cSH	1607	1600	932	936
Volume to Capacity	0.00	0.00	0.02	0.02
Queue Length 95th (ft)	0	0	1	1
Control Delay (s)	0.0	1.5	8.9	8.9
Lane LOS		A	A	A
Approach Delay (s)	0.0	1.5	8.9	8.9
Approach LOS			A	A

Intersection Summary			
Average Delay	3.8		
Intersection Capacity Utilization	15.7%	ICU Level of Service	A
Analysis Period (min)	15		

15: 183rd Street & Gardner Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Volume (vph)	30	20	30	50	30	40	70	270	110	60	240	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.91		1.00	0.91		1.00	0.96		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1752	1676		1770	1687		1787	3316		1770	3401	
Flt Permitted	0.89	1.00		0.89	1.00		0.56	1.00		0.50	1.00	
Satd. Flow (perm)	1640	1676		1656	1687		1055	3316		937	3401	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	34	22	34	56	34	45	79	303	124	67	270	45
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	34	56	0	56	79	0	79	427	0	67	315	0
Heavy Vehicles (%)	3%	0%	5%	2%	3%	3%	1%	5%	2%	2%	4%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	4.5	4.5		4.5	4.5		15.3	15.3		15.3	15.3	
Effective Green, g (s)	4.5	4.5		4.5	4.5		15.3	15.3		15.3	15.3	
Actuated g/C Ratio	0.15	0.15		0.15	0.15		0.51	0.51		0.51	0.51	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	248	253		250	255		542	1703		481	1746	
v/s Ratio Prot		0.03			c0.05			c0.13			0.09	
v/s Ratio Perm	0.02			0.03			0.07			0.07		
v/c Ratio	0.14	0.22		0.22	0.31		0.15	0.25		0.14	0.18	
Uniform Delay, d1	11.0	11.1		11.1	11.3		3.8	4.0		3.8	3.9	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.3	0.4		0.5	0.7		0.1	0.1		0.1	0.0	
Delay (s)	11.2	11.6		11.6	12.0		3.9	4.1		3.9	3.9	
Level of Service	B	B		B	B		A	A		A	A	
Approach Delay (s)		11.4			11.8			4.1			3.9	
Approach LOS		B			B			A			A	

Intersection Summary			
HCM Average Control Delay	5.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.26		
Actuated Cycle Length (s)	29.8	Sum of lost time (s)	10.0
Intersection Capacity Utilization	38.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

16: Four Corners Road & US 56

PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✥			✥			✥			✥	
Volume (veh/h)	5	5	5	0	5	5	5	150	5	5	280	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	7	7	7	0	7	7	7	197	7	7	368	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	605	595	201	605	599	368	368			204		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	605	595	201	605	599	368	368			204		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	100	98	99	99			100		
cM capacity (veh/h)	400	416	845	401	414	682	1201			1380		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	20	13	211	375
Volume Left	7	0	7	7
Volume Right	7	7	7	0
cSH	493	515	1201	1380
Volume to Capacity	0.04	0.03	0.01	0.00
Queue Length 95th (ft)	3	2	0	0
Control Delay (s)	12.6	12.2	0.3	0.2
Lane LOS	B	B	A	A
Approach Delay (s)	12.6	12.2	0.3	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	28.7%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Gardner No Action - (Improved) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)
17: 191st Street & US 56 — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	0	0	5	5	0	0	150	0	0	280	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	0	0	0	6	6	0	0	195	0	0	364	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	565	562	367	562	565	195	370			195		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	565	562	367	562	565	195	370			195		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	99	99	100	100			100		
cM capacity (veh/h)	434	439	683	441	437	852	1199			1390		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	0	13	195	370
Volume Left	0	6	0	0
Volume Right	0	0	0	6
cSH	1700	439	1199	1390
Volume to Capacity	0.00	0.03	0.00	0.00
Queue Length 95th (ft)	0	2	0	0
Control Delay (s)	0.0	13.5	0.0	0.0
Lane LOS	A	B		
Approach Delay (s)	0.0	13.5	0.0	0.0
Approach LOS	A	B		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	25.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)
18: 191st Street & Four Corners Road — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	10	10	10	5	5	5
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	11	11	5	5	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	30	14			16	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	30	14			16	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	99			100	
cM capacity (veh/h)	986	1072			1614	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	22	16	11
Volume Left	11	0	5
Volume Right	11	5	0
cSH	1027	1700	1614
Volume to Capacity	0.02	0.01	0.00
Queue Length 95th (ft)	2	0	0
Control Delay (s)	8.6	0.0	3.6
Lane LOS	A		A
Approach Delay (s)	8.6	0.0	3.6
Approach LOS	A		

Intersection Summary			
Average Delay	4.6		
Intersection Capacity Utilization	14.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)
19: 191st Street & Waverly Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	5	0	5	10	10	5	5	5	5	5	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	0	5	11	11	5	5	5	5	5	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	22			5			52	49	5	52	43	16
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	22			5			52	49	5	52	43	16
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			99	99	99	99	99	99
cM capacity (veh/h)	1607			1629			938	841	1083	938	847	1069

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	11	27	16	16
Volume Left	5	5	5	5
Volume Right	0	11	5	5
cSH	1607	1629	944	943
Volume to Capacity	0.00	0.00	0.02	0.02
Queue Length 95th (ft)	0	0	1	1
Control Delay (s)	3.6	1.5	8.9	8.9
Lane LOS	A	A	A	A
Approach Delay (s)	3.6	1.5	8.9	8.9
Approach LOS			A	A

Intersection Summary			
Average Delay	5.2		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)
20: W 191st Street & Gardner Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	5	30	20	5	20	20	510	20	20	380	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00			0.95			0.95	1.00
Frt	1.00	1.00	0.85		0.94			0.99			1.00	0.85
Flt Protected	0.95	1.00	1.00		0.98			1.00			1.00	1.00
Satd. Flow (prot)	1805	1900	1468		1746			3419			3501	1468
Flt Permitted	0.85	1.00	1.00		0.85			0.94			0.92	1.00
Satd. Flow (perm)	1617	1900	1468		1523			3204			3226	1468
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	11	5	32	22	5	22	21	537	22	22	400	11
RTOR Reduction (vph)	0	0	30	0	20	0	0	2	0	0	0	2
Lane Group Flow (vph)	11	5	2	0	29	0	0	578	0	0	422	9
Heavy Vehicles (%)	0%	0%	10%	0%	0%	0%	5%	5%	0%	0%	3%	10%
Turn Type	Perm		Perm	Perm			Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	4.7	4.7	4.7		4.7			50.3			50.3	50.3
Effective Green, g (s)	4.7	4.7	4.7		4.7			50.3			50.3	50.3
Actuated g/C Ratio	0.07	0.07	0.07		0.07			0.77			0.77	0.77
Clearance Time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	117	137	106		110			2479			2496	1136
v/s Ratio Prot		0.00										
v/s Ratio Perm	0.01		0.00		c0.02			c0.18			0.13	0.01
v/c Ratio	0.09	0.04	0.02		0.26			0.23			0.17	0.01
Uniform Delay, d1	28.2	28.0	28.0		28.5			2.0			1.9	1.7
Progression Factor	1.00	1.00	1.00		1.00			0.81			1.00	1.00
Incremental Delay, d2	0.4	0.1	0.1		1.3			0.2			0.1	0.0
Delay (s)	28.5	28.2	28.1		29.8			1.8			2.1	1.7
Level of Service	C	C	C		C			A			A	A
Approach Delay (s)		28.2			29.8			1.8			2.0	
Approach LOS		C			C			A			A	

Intersection Summary			
HCM Average Control Delay	4.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.24		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	47.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

21: I-35 SB Ramps & Gardner Rd

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	150	0	390	10	150	0	0	350	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0		5.0		5.0			5.0	5.0
Lane Util. Factor				1.00		1.00		1.00			1.00	1.00
Frt				1.00		0.85		1.00			1.00	0.85
Flt Protected				0.95		1.00		1.00			1.00	1.00
Satd. Flow (prot)				1752		1538		1831			1845	1538
Flt Permitted				0.95		1.00		0.98			1.00	1.00
Satd. Flow (perm)				1752		1538		1793			1845	1538
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	160	0	415	11	160	0	0	372	85
RTOR Reduction (vph)	0	0	0	0	0	338	0	0	0	0	0	29
Lane Group Flow (vph)	0	0	0	160	0	77	0	171	0	0	372	56
Heavy Vehicles (%)	0%	0%	0%	3%	0%	5%	10%	3%	0%	0%	3%	5%
Turn Type				Prot		custom	Perm					Perm
Protected Phases				3				2			6	
Permitted Phases						3	2					6
Actuated Green, G (s)				12.0		12.0		43.0			43.0	43.0
Effective Green, g (s)				12.0		12.0		43.0			43.0	43.0
Actuated g/C Ratio				0.18		0.18		0.66			0.66	0.66
Clearance Time (s)				5.0		5.0		5.0			5.0	5.0
Vehicle Extension (s)				3.0		3.0		3.0			3.0	3.0
Lane Grp Cap (vph)				323		284		1186			1221	1017
v/s Ratio Prot				c0.09							c0.20	
v/s Ratio Perm						0.05		0.10				0.04
v/c Ratio				0.50		0.27		0.14			0.30	0.06
Uniform Delay, d1				23.8		22.7		4.1			4.7	3.9
Progression Factor				1.00		1.00		0.86			0.85	0.69
Incremental Delay, d2				1.2		0.5		0.3			0.6	0.1
Delay (s)				25.0		23.3		3.8			4.6	2.8
Level of Service				C		C		A			A	A
Approach Delay (s)		0.0			23.7			3.8			4.2	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM Average Control Delay	13.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.35		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	40.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

22: I-35 NB Ramps & Gardner Rd

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	0	20	0	0	0	0	120	40	210	280	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.96						0.97			1.00	
Flt Protected		0.97						1.00			0.98	
Satd. Flow (prot)		1641						1774			1796	
Flt Permitted		0.97						1.00			0.79	
Satd. Flow (perm)		1641						1774			1441	
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	44	0	22	0	0	0	0	132	44	231	308	0
RTOR Reduction (vph)	0	21	0	0	0	0	0	10	0	0	0	0
Lane Group Flow (vph)	0	45	0	0	0	0	0	166	0	0	539	0
Heavy Vehicles (%)	8%	0%	5%	0%	0%	0%	0%	3%	5%	7%	1%	0%
Turn Type	Perm									Perm		
Protected Phases		4						2			6	
Permitted Phases	4									6		
Actuated Green, G (s)		4.2						50.8			50.8	
Effective Green, g (s)		4.2						50.8			50.8	
Actuated g/C Ratio		0.06						0.78			0.78	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		106						1386			1126	
v/s Ratio Prot								0.09				
v/s Ratio Perm		0.03									c0.37	
v/c Ratio		0.43						0.12			0.48	
Uniform Delay, d1		29.2						1.7			2.5	
Progression Factor		1.00						1.00			0.65	
Incremental Delay, d2		2.8						0.2			1.4	
Delay (s)		32.0						1.9			3.0	
Level of Service		C						A			A	
Approach Delay (s)		32.0			0.0			1.9			3.0	
Approach LOS		C			A			A			A	

Intersection Summary			
HCM Average Control Delay	5.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	53.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

23: E 191st Street & Gardner Rd

PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	5	150	5	10	290
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	5	161	5	11	312
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						220
pX, platoon unblocked						
vC, conflicting volume	497	164			167	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	497	164			167	
tC, single (s)	6.4	6.4			4.2	
tC, 2 stage (s)						
tF (s)	3.5	3.5			2.3	
p0 queue free %	100	99			99	
cM capacity (veh/h)	532	836			1364	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	5	167	323
Volume Left	0	0	11
Volume Right	5	5	0
cSH	836	1700	1364
Volume to Capacity	0.01	0.10	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	9.3	0.0	0.3
Lane LOS	A		A
Approach Delay (s)	9.3	0.0	0.3
Approach LOS	A		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	33.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)

24: Sunflower Road & US 56

PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	5	10	30	5	0	10	150	30	0	290	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	6	13	38	6	0	13	190	38	0	367	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	608	623	370	620	608	209	373			228		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	608	623	370	620	608	209	373			228		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	98	98	90	98	100	99			100		
cM capacity (veh/h)	403	400	680	383	409	837	1196			1352		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	19	44	241	373
Volume Left	0	38	13	0
Volume Right	13	0	38	6
cSH	552	387	1196	1352
Volume to Capacity	0.03	0.11	0.01	0.00
Queue Length 95th (ft)	3	10	1	0
Control Delay (s)	11.8	15.5	0.5	0.0
Lane LOS	B	C	A	
Approach Delay (s)	11.8	15.5	0.5	0.0
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	33.3%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Gardner No Action - (Improved) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)
25: US 56 & 4th Street
PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	170	20	30	310	60	20
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	218	26	38	397	77	26
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			244		705	231
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			244		705	231
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		80	97
cM capacity (veh/h)			1335		391	813

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	244	436	103
Volume Left	0	38	77
Volume Right	26	0	26
cSH	1700	1335	449
Volume to Capacity	0.14	0.03	0.23
Queue Length 95th (ft)	0	2	22
Control Delay (s)	0.0	1.0	15.4
Lane LOS		A	C
Approach Delay (s)	0.0	1.0	15.4
Approach LOS			C

Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	42.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)
26: 199th Street & Four Corners Road
PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	30	40	5	10	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	6	36	48	6	12	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	54				98	51
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	54				98	51
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	99
cM capacity (veh/h)	1565				902	1023

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	42	54	18
Volume Left	6	0	12
Volume Right	0	6	6
cSH	1565	1700	939
Volume to Capacity	0.00	0.03	0.02
Queue Length 95th (ft)	0	0	1
Control Delay (s)	1.1	0.0	8.9
Lane LOS	A		A
Approach Delay (s)	1.1	0.0	8.9
Approach LOS			A

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	15.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)
27: 199th Street & Gardner Road
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	20	20	10	30	30	10	80	10	30	170	40
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	22	22	22	11	34	34	11	90	11	34	191	45

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	67	79	112	270
Volume Left (vph)	22	11	11	34
Volume Right (vph)	22	34	11	45
Hadj (s)	-0.13	-0.18	0.01	-0.04
Departure Headway (s)	4.7	4.7	4.6	4.4
Degree Utilization, x	0.09	0.10	0.14	0.33
Capacity (veh/h)	690	701	747	792
Control Delay (s)	8.2	8.2	8.3	9.5
Approach Delay (s)	8.2	8.2	8.3	9.5
Approach LOS	A	A	A	A

Intersection Summary			
Delay	8.9		
HCM Level of Service	A		
Intersection Capacity Utilization	31.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner No-Action - (Improved)
30: US-56 & I-35 NB Loop
PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	460	980	0	560	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	517	1101	0	629	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked						
vC, conflicting volume			1618		831	258
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1618		831	258
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			408		312	747

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	258	258	1101	315	315
Volume Left	0	0	0	0	0
Volume Right	0	0	1101	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.15	0.15	0.65	0.19	0.19
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	64.0%	ICU Level of Service	C
Analysis Period (min)	15		

2010 Proposed Action - AM Peak Hour - Synchro Intersection LOS

1: 175th Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	60	290	5	0	50	50	5	80	5	90	30	10
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	72	349	6	0	60	60	6	96	6	108	36	12
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	120			355			617	617	352	642	590	90
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	120			355			617	617	352	642	590	90
tC, single (s)	4.1			4.1			7.3	6.5	6.2	7.1	6.5	6.3
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.7	4.0	3.3	3.5	4.0	3.4
p0 queue free %	95			100			98	75	99	63	91	99
cM capacity (veh/h)	1449			1214			333	384	696	296	398	946

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	428	120	108	157
Volume Left	72	0	6	108
Volume Right	6	60	6	12
cSH	1449	1214	390	333
Volume to Capacity	0.05	0.00	0.28	0.47
Queue Length 95th (ft)	4	0	28	60
Control Delay (s)	1.7	0.0	17.7	25.0
Lane LOS	A		C	D
Approach Delay (s)	1.7	0.0	17.7	25.0
Approach LOS			C	D

Intersection Summary			
Average Delay	8.1		
Intersection Capacity Utilization	46.1%	ICU Level of Service	A
Analysis Period (min)	15		

2: US 56 & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	560	60	100	220	100	70	320	190	140	200	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.99			0.96		1.00	0.94		1.00	0.98	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3363			3175		1805	1725		1736	1794	
Flt Permitted		0.89			0.63		0.60	1.00		0.23	1.00	
Satd. Flow (perm)		3018			2010		1133	1725		424	1794	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	46	644	69	115	253	115	80	368	218	161	230	34
RTOR Reduction (vph)	0	14	0	0	56	0	0	46	0	0	11	0
Lane Group Flow (vph)	0	745	0	0	427	0	80	540	0	161	253	0
Heavy Vehicles (%)	5%	6%	2%	7%	10%	6%	0%	4%	4%	4%	4%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		19.2			19.2		19.1	19.1		19.1	19.1	
Effective Green, g (s)		19.2			19.2		19.1	19.1		19.1	19.1	
Actuated g/C Ratio		0.38			0.38		0.38	0.38		0.38	0.38	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1159			772		433	659		162	685	
v/s Ratio Prot								0.31			0.14	
v/s Ratio Perm		c0.25			0.21		0.07			c0.38		
v/c Ratio		0.64			0.55		0.18	0.82		0.99	0.37	
Uniform Delay, d1		12.6			12.0		10.3	13.9		15.4	11.1	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		2.7			2.8		0.2	7.9		68.6	0.3	
Delay (s)		15.3			14.9		10.5	21.8		83.9	11.5	
Level of Service		B			B		B	C		F	B	
Approach Delay (s)		15.3			14.9			20.4			38.9	
Approach LOS		B			B			C			D	

Intersection Summary			
HCM Average Control Delay	21.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	50.0	Sum of lost time (s)	11.7
Intersection Capacity Utilization	87.0%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

3: US 56 & Elm

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	870	10	10	390	40	10	5	20	70	5	20
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			0.99			0.92			0.97	
Flt Protected		1.00			1.00			0.99			0.96	
Satd. Flow (prot)		3615			3467			1817			1853	
Flt Permitted		0.94			0.93			0.92			0.76	
Satd. Flow (perm)		3404			3240			1699			1458	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	22	935	11	11	419	43	11	5	22	75	5	22
RTOR Reduction (vph)	0	1	0	0	6	0	0	19	0	0	19	0
Lane Group Flow (vph)	0	967	0	0	467	0	0	19	0	0	83	0
Heavy Vehicles (%)	0%	5%	0%	0%	9%	0%	0%	0%	0%	0%	0%	5%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		47.4			47.4			8.6			8.6	
Effective Green, g (s)		47.4			47.4			8.6			8.6	
Actuated g/C Ratio		0.73			0.73			0.13			0.13	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2482			2363			225			193	
v/s Ratio Prot												
v/s Ratio Perm		c0.28			0.14			0.01			c0.06	
v/c Ratio		0.39			0.20			0.08			0.43	
Uniform Delay, d1		3.3			2.8			24.7			25.9	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.5			0.0			0.2			1.5	
Delay (s)		3.8			2.8			24.9			27.5	
Level of Service		A			A			C			C	
Approach Delay (s)		3.8			2.8			24.9			27.5	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	5.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	55.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

4: US 56 & Mulberry

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	960	10	10	390	50	5	5	20	90	5	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			0.98			0.91			0.97	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3427			3262			1605			1737	
Flt Permitted		0.93			0.93			0.95			0.77	
Satd. Flow (perm)		3206			3041			1543			1378	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	32	1032	11	11	419	54	5	5	22	97	5	32
RTOR Reduction (vph)	0	2	0	0	17	0	0	20	0	0	26	0
Lane Group Flow (vph)	0	1073	0	0	467	0	0	12	0	0	108	0
Heavy Vehicles (%)	7%	5%	0%	0%	9%	8%	0%	20%	5%	2%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		31.2			31.2			4.8			4.8	
Effective Green, g (s)		31.2			31.2			4.8			4.8	
Actuated g/C Ratio		0.69			0.69			0.11			0.11	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2223			2108			165			147	
v/s Ratio Prot												
v/s Ratio Perm		c0.33			0.15			0.01			c0.08	
v/c Ratio		0.48			0.22			0.07			0.74	
Uniform Delay, d1		3.2			2.5			18.1			19.5	
Progression Factor		1.00			0.47			1.00			1.00	
Incremental Delay, d2		0.8			0.1			0.2			17.3	
Delay (s)		3.9			1.2			18.3			36.8	
Level of Service		A			A			B			D	
Approach Delay (s)		3.9			1.2			18.3			36.8	
Approach LOS		A			A			B			D	

Intersection Summary			
HCM Average Control Delay	6.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	45.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	69.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

5: US 56 & Moonlight Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	910	130	40	290	160	120	120	110	430	150	50
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1703	3619	1568	1752	3252	1583	1752	3505	1538	3400	3505	1524
Flt Permitted	0.54	1.00	1.00	0.20	1.00	1.00	0.65	1.00	1.00	0.43	1.00	1.00
Satd. Flow (perm)	970	3619	1568	369	3252	1583	1194	3505	1538	1546	3505	1524
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	77	1000	143	44	319	176	132	132	121	473	165	55
RTOR Reduction (vph)	0	0	77	0	0	97	0	0	109	0	0	47
Lane Group Flow (vph)	77	1000	66	44	319	79	132	132	12	473	165	8
Heavy Vehicles (%)	6%	5%	3%	3%	11%	2%	3%	3%	5%	3%	3%	6%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6	8		8	4		4
Actuated Green, G (s)	46.5	41.6	41.6	43.9	40.3	40.3	17.1	8.6	8.6	26.5	13.3	13.3
Effective Green, g (s)	46.5	41.6	41.6	43.9	40.3	40.3	17.1	8.6	8.6	26.5	13.3	13.3
Actuated g/C Ratio	0.52	0.46	0.46	0.49	0.45	0.45	0.19	0.10	0.10	0.29	0.15	0.15
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	541	1673	725	235	1456	709	280	335	147	727	518	225
v/s Ratio Prot	c0.01	c0.28		0.01	0.10		0.04	0.04		c0.10	0.05	
v/s Ratio Perm	0.07		0.04	0.08		0.05	0.05		0.01	c0.10		0.01
v/c Ratio	0.14	0.60	0.09	0.19	0.22	0.11	0.47	0.39	0.08	0.65	0.32	0.04
Uniform Delay, d1	11.0	18.0	13.6	13.0	15.2	14.4	31.9	38.3	37.1	26.2	34.3	32.9
Progression Factor	0.88	0.89	1.43	0.90	1.11	2.06	0.93	0.93	0.71	1.00	1.00	1.00
Incremental Delay, d2	0.0	1.4	0.2	0.1	0.3	0.3	0.5	0.3	0.1	1.6	0.1	0.0
Delay (s)	9.7	17.5	19.6	11.9	17.3	30.1	30.1	36.0	26.5	27.8	34.4	32.9
Level of Service	A	B	B	B	B	C	C	D	C	C	C	C
Approach Delay (s)		17.3			21.0			31.0			29.8	
Approach LOS		B			C			C			C	

Intersection Summary			
HCM Average Control Delay	22.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	16.5
Intersection Capacity Utilization	67.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

6: Old US 56 & US 56 — AM Peak Hour

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	40	10	1250	210	10	470
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	4.0	5.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1752	1615	3654	1568	1805	3551
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1752	1615	3654	1568	1805	3551
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	41	10	1289	216	10	485
RTOR Reduction (vph)	0	9	0	83	0	0
Lane Group Flow (vph)	41	1	1289	133	10	485
Heavy Vehicles (%)	3%	0%	4%	3%	0%	7%
Turn Type		Perm		custom	Prot	
Protected Phases	8		2	4	1	6
Permitted Phases		8				
Actuated Green, G (s)	12.7	12.7	61.9	12.7	1.4	67.3
Effective Green, g (s)	12.7	12.7	61.9	12.7	1.4	67.3
Actuated g/C Ratio	0.14	0.14	0.69	0.14	0.02	0.75
Clearance Time (s)	5.0	5.0	5.0	5.0	4.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	247	228	2513	221	28	2655
v/s Ratio Prot	0.02		c0.35	c0.08	0.01	c0.14
v/s Ratio Perm		0.00				
v/c Ratio	0.17	0.01	0.51	0.60	0.36	0.18
Uniform Delay, d1	34.0	33.2	6.8	36.3	43.9	3.3
Progression Factor	1.00	1.00	0.59	1.47	1.30	0.72
Incremental Delay, d2	0.3	0.0	0.6	3.7	6.8	0.1
Delay (s)	34.3	33.2	4.6	57.1	63.6	2.5
Level of Service	C	C	A	E	E	A
Approach Delay (s)	34.1		12.1			3.8
Approach LOS	C		B			A

Intersection Summary			
HCM Average Control Delay	10.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	47.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

7: US-56 & Cedar Niles — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	1280	90	230	1100	60	80	20	450	40	10	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00		1.00	0.88	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85	1.00	0.88	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1805	3689	1615	3433	3689	1615		1827	2842	1752	1606	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.73	1.00	0.68	1.00	
Satd. Flow (perm)	1805	3689	1615	3433	3689	1615		1387	2842	1263	1606	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	45	1438	101	258	1236	67	90	22	506	45	11	45
RTOR Reduction (vph)	0	0	45	0	0	24	0	0	0	0	39	0
Lane Group Flow (vph)	45	1438	56	258	1236	43	0	112	506	45	17	0
Heavy Vehicles (%)	0%	3%	0%	2%	3%	0%	0%	0%	0%	3%	0%	5%
Turn Type	Prot		Perm	Prot		Perm	Perm		pt+ov	Perm		
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases			2			6	8			4		
Actuated Green, G (s)	4.8	50.2	50.2	12.6	58.0	58.0		11.6	28.2	11.6	11.6	
Effective Green, g (s)	4.8	50.2	50.2	12.6	58.0	58.0		11.6	24.2	11.6	11.6	
Actuated g/C Ratio	0.05	0.56	0.56	0.14	0.64	0.64		0.13	0.27	0.13	0.13	
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2		5.2	5.2	
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0		1.0		1.0	1.0	
Lane Grp Cap (vph)	96	2058	901	481	2377	1041		179	764	163	207	
v/s Ratio Prot	0.02	c0.39		0.08	0.34				c0.18		0.01	
v/s Ratio Perm			0.03			0.03		0.08		0.04		
v/c Ratio	0.47	0.70	0.06	0.54	0.52	0.04		0.63	0.66	0.28	0.08	
Uniform Delay, d1	41.4	14.4	9.1	36.0	8.6	5.8		37.1	29.3	35.4	34.5	
Progression Factor	1.12	0.62	0.42	0.87	0.78	0.77		1.00	1.00	1.00	1.00	
Incremental Delay, d2	1.2	1.9	0.1	0.5	0.7	0.1		4.8	1.7	0.3	0.1	
Delay (s)	47.6	10.8	3.9	31.9	7.3	4.6		42.0	30.9	35.7	34.6	
Level of Service	D	B	A	C	A	A		D	C	D	C	
Approach Delay (s)		11.4			11.3			32.9			35.1	
Approach LOS		B			B			C			D	

Intersection Summary			
HCM Average Control Delay	15.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	16.8
Intersection Capacity Utilization	71.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

8: US-56 & I-35 SB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1720	40	30	470	0	0	0	0	50	0	920
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					2.5		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		1.00		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3513		1641	3689					1641		2760
Flt Permitted		1.00		0.95	1.00					0.95		1.00
Satd. Flow (perm)		3513		1641	3689					1641		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1811	42	32	495	0	0	0	0	53	0	968
RTOR Reduction (vph)	0	1	0	0	0	0	0	0	0	0	0	301
Lane Group Flow (vph)	0	1852	0	32	495	0	0	0	0	53	0	667
Heavy Vehicles (%)	0%	2%	20%	10%	3%	0%	0%	0%	0%	10%	0%	3%
Turn Type				Prot						Prot		custom
Protected Phases		2		1	6					7		5
Permitted Phases												4
Actuated Green, G (s)		67.8		4.2	42.0					5.5		30.0
Effective Green, g (s)		67.8		4.2	42.0					5.5		30.0
Actuated g/C Ratio		0.75		0.05	0.47					0.06		0.33
Clearance Time (s)		5.0		5.0	5.0					2.5		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2646		77	1722					100		920
v/s Ratio Prot		c0.53		0.02	c0.13					c0.03		0.24
v/s Ratio Perm												
v/c Ratio		0.70		0.42	0.29					0.53		0.73
Uniform Delay, d1		5.8		41.7	14.8					41.0		26.4
Progression Factor		0.54		1.07	0.82					1.00		1.00
Incremental Delay, d2		1.2		3.3	0.4					5.3		2.9
Delay (s)		4.4		47.8	12.6					46.3		29.2
Level of Service		A		D	B					D		C
Approach Delay (s)		4.4			14.7			0.0			30.1	
Approach LOS		A			B			A			C	

Intersection Summary			
HCM Average Control Delay	13.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.5
Intersection Capacity Utilization	59.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

2010 Proposed Action - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

9: US-56 & I-35 NB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	350	0	0	350	130	150	0	90	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			0.96			0.95				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3725			1795			1625				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3725			1795			1625				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	398	0	0	398	148	170	0	102	0	0	0
RTOR Reduction (vph)	0	0	0	0	11	0	0	29	0	0	0	0
Lane Group Flow (vph)	0	398	0	0	535	0	0	243	0	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	2%	8%	0%	7%	0%	0%	0%
Turn Type				Perm			Perm					
Protected Phases		2			6			8				
Permitted Phases				6			8					
Actuated Green, G (s)		61.3			61.3			18.7				
Effective Green, g (s)		61.3			61.3			18.7				
Actuated g/C Ratio		0.68			0.68			0.21				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		2537			1223			338				
v/s Ratio Prot		0.11			c0.30							
v/s Ratio Perm								0.15				
v/c Ratio		0.16			0.44			0.72				
Uniform Delay, d1		5.1			6.5			33.2				
Progression Factor		0.45			1.00			1.00				
Incremental Delay, d2		0.1			1.1			7.4				
Delay (s)		2.4			7.7			40.6				
Level of Service		A			A			D				
Approach Delay (s)		2.4			7.7			40.6			0.0	
Approach LOS		A			A			D			A	

Intersection Summary			
HCM Average Control Delay	13.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	91.3%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

10: Sante Fe & — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	40	90	260	70	120	190
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.97		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1752	1583	3382		1770	3471
Flt Permitted	0.95	1.00	1.00		0.54	1.00
Satd. Flow (perm)	1752	1583	3382		1005	3471
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	43	97	280	75	129	204
RTOR Reduction (vph)	0	90	12	0	0	0
Lane Group Flow (vph)	43	7	343	0	129	204
Heavy Vehicles (%)	3%	2%	4%	1%	2%	4%
Turn Type		Perm			Perm	
Protected Phases	6		8			4
Permitted Phases		6			4	
Actuated Green, G (s)	6.7	6.7	73.3		73.3	73.3
Effective Green, g (s)	6.7	6.7	73.3		73.3	73.3
Actuated g/C Ratio	0.07	0.07	0.81		0.81	0.81
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	130	118	2754		819	2827
v/s Ratio Prot	c0.02		0.10			0.06
v/s Ratio Perm		0.00			c0.13	
v/c Ratio	0.33	0.06	0.12		0.16	0.07
Uniform Delay, d1	39.5	38.7	1.7		1.8	1.6
Progression Factor	1.00	1.00	1.00		0.59	0.45
Incremental Delay, d2	1.5	0.2	0.1		0.4	0.0
Delay (s)	41.0	38.9	1.8		1.4	0.8
Level of Service	D	D	A		A	A
Approach Delay (s)	39.6		1.8			1.0
Approach LOS	D		A			A

Intersection Summary			
HCM Average Control Delay	7.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.17		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	34.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

11: Waverly Road & US 56 — AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	20	10	10	10	10	60	250	0	10	80	10
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	25	13	13	13	13	76	316	0	13	101	13
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	620	608	316	627	601	108	114			316		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	620	608	316	627	601	108	114			316		
tC, single (s)	7.1	6.6	6.5	7.1	6.6	6.3	4.1			4.3		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.6	3.5	4.1	3.4	2.2			2.4		
p0 queue free %	100	93	98	96	97	99	95			99		
cM capacity (veh/h)	369	381	664	354	378	925	1469			1149		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	38	38	392	127
Volume Left	0	13	76	13
Volume Right	13	13	0	13
cSH	444	458	1469	1149
Volume to Capacity	0.09	0.08	0.05	0.01
Queue Length 95th (ft)	7	7	4	1
Control Delay (s)	13.9	13.6	1.9	0.9
Lane LOS	B	B	A	A
Approach Delay (s)	13.9	13.6	1.9	0.9
Approach LOS	B	B		

Intersection Summary			
Average Delay	3.2		
Intersection Capacity Utilization	38.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

12: 183rd Street & Four Corners Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	5	5	5	10	5	10	10	5	5	10	5
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	5	5	11	5	11	11	5	5	11	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	16	22	27	22
Volume Left (vph)	5	5	11	5
Volume Right (vph)	5	5	5	5
Hadj (s)	-0.13	-0.10	-0.04	-0.10
Departure Headway (s)	3.9	3.9	4.0	3.9
Degree Utilization, x	0.02	0.02	0.03	0.02
Capacity (veh/h)	907	902	887	907
Control Delay (s)	7.0	7.0	7.1	7.0
Approach Delay (s)	7.0	7.0	7.1	7.0
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.0		
HCM Level of Service	A		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action
13: 183rd Street & US 56 — AM Peak Hour

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	5	0	0	310	80	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	0	0	392	101	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	497	104	108			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	497	104	108			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	99	100	100			
cM capacity (veh/h)	536	956	1496			

Direction, Lane #	SE 1	NE 1	SW 1
Volume Total	6	392	108
Volume Left	6	0	0
Volume Right	0	0	6
cSH	536	1496	1700
Volume to Capacity	0.01	0.00	0.06
Queue Length 95th (ft)	1	0	0
Control Delay (s)	11.8	0.0	0.0
Lane LOS	B		
Approach Delay (s)	11.8	0.0	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	26.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action
14: 183rd Street & Waverly Road — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	10	10	20	10	5	20
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	11	22	11	5	22
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	60	27			33	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	60	27			33	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	99			100	
cM capacity (veh/h)	949	1054			1592	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	22	33	27
Volume Left	11	0	5
Volume Right	11	11	0
cSH	999	1700	1592
Volume to Capacity	0.02	0.02	0.00
Queue Length 95th (ft)	2	0	0
Control Delay (s)	8.7	0.0	1.5
Lane LOS	A		A
Approach Delay (s)	8.7	0.0	1.5
Approach LOS	A		

Intersection Summary			
Average Delay	2.8		
Intersection Capacity Utilization	15.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action
15: 183rd Street & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	20	90	110	20	90	30	410	40	30	340	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.88		1.00	0.88		1.00	0.99		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1805	1666		1805	1666		1805	3437		1805	3482	
Flt Permitted	0.68	1.00		0.68	1.00		0.51	1.00		0.47	1.00	
Satd. Flow (perm)	1288	1666		1288	1666		977	3437		885	3482	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	45	22	101	124	22	101	34	461	45	34	382	22
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	45	123	0	124	123	0	34	506	0	34	404	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	4%	0%	0%	3%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	7.1	7.1		7.1	7.1		13.5	13.5		13.5	13.5	
Effective Green, g (s)	7.1	7.1		7.1	7.1		13.5	13.5		13.5	13.5	
Actuated g/C Ratio	0.23	0.23		0.23	0.23		0.44	0.44		0.44	0.44	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	299	387		299	387		431	1516		390	1536	
v/s Ratio Prot		0.07			0.07			c0.15			0.12	
v/s Ratio Perm	0.03			c0.10			0.03			0.04		
v/c Ratio	0.15	0.32		0.41	0.32		0.08	0.33		0.09	0.26	
Uniform Delay, d1	9.4	9.7		10.0	9.7		5.0	5.6		5.0	5.4	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.2	0.5		0.9	0.5		0.1	0.1		0.1	0.1	
Delay (s)	9.6	10.2		10.9	10.2		5.0	5.7		5.1	5.5	
Level of Service	A	B		B	B		A	A		A	A	
Approach Delay (s)		10.0			10.6			5.7			5.5	
Approach LOS		B			B			A			A	

Intersection Summary			
HCM Average Control Delay	7.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.36		
Actuated Cycle Length (s)	30.6	Sum of lost time (s)	10.0
Intersection Capacity Utilization	43.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action
16: Four Corners Road & US 56 — AM Peak Hour

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	0	5	10	310	90	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	0	7	13	408	118	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	553	118	118			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	553	118	118			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	99	99			
cM capacity (veh/h)	493	939	1482			

Direction, Lane #	SB 1	NE 1	SW 1
Volume Total	7	421	118
Volume Left	0	13	0
Volume Right	7	0	0
cSH	939	1482	1700
Volume to Capacity	0.01	0.01	0.07
Queue Length 95th (ft)	1	1	0
Control Delay (s)	8.9	0.3	0.0
Lane LOS	A	A	
Approach Delay (s)	8.9	0.3	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	33.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action
17: 191st Street & US 56 — AM Peak Hour

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	10	5	0	320	90	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	13	6	0	416	117	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	536	120	123			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	536	120	123			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	99	100			
cM capacity (veh/h)	509	937	1476			

Direction, Lane #	SE 1	NE 1	SW 1
Volume Total	19	416	123
Volume Left	13	0	0
Volume Right	6	0	6
cSH	600	1476	1700
Volume to Capacity	0.03	0.00	0.07
Queue Length 95th (ft)	3	0	0
Control Delay (s)	11.2	0.0	0.0
Lane LOS	B		
Approach Delay (s)	11.2	0.0	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	26.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action
19: 191st Street & Waverly Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	110	5	5	70	30	5	5	5	30	5	10
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	120	5	5	76	33	5	5	5	33	5	11
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	109			125			261	264	122	255	250	92
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	109			125			261	264	122	255	250	92
tC, single (s)	4.5			4.1			7.1	6.5	6.2	7.1	6.5	6.5
tC, 2 stage (s)												
tF (s)	2.6			2.2			3.5	4.0	3.3	3.5	4.0	3.6
p0 queue free %	99			100			99	99	99	95	99	99
cM capacity (veh/h)	1276			1474			677	637	934	687	648	893

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	136	114	16	49
Volume Left	11	5	5	33
Volume Right	5	33	5	11
cSH	1276	1474	729	719
Volume to Capacity	0.01	0.00	0.02	0.07
Queue Length 95th (ft)	1	0	2	5
Control Delay (s)	0.7	0.4	10.1	10.4
Lane LOS	A	A	B	B
Approach Delay (s)	0.7	0.4	10.1	10.4
Approach LOS			B	B

Intersection Summary			
Average Delay	2.6		
Intersection Capacity Utilization	21.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action
20: W 191st Street & Gardner Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	5	140	10	5	10	100	250	5	5	490	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00			0.95			0.95	1.00
Frt	1.00	1.00	0.85		0.94			1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00		0.98			0.99			1.00	1.00
Satd. Flow (prot)	1805	1900	1022		1760			2968			3538	1346
Flt Permitted	0.74	1.00	1.00		0.88			0.72			0.95	1.00
Satd. Flow (perm)	1405	1900	1022		1588			2162			3371	1346
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	11	5	147	11	5	11	105	263	5	5	516	5
RTOR Reduction (vph)	0	0	131	0	10	0	0	0	0	0	0	1
Lane Group Flow (vph)	11	5	16	0	17	0	0	373	0	0	521	4
Heavy Vehicles (%)	0%	0%	58%	0%	0%	0%	55%	6%	0%	0%	2%	20%
Turn Type	Perm		Perm	Perm			Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	9.1	9.1	9.1		9.1			65.9			65.9	65.9
Effective Green, g (s)	9.1	9.1	9.1		9.1			65.9			65.9	65.9
Actuated g/C Ratio	0.11	0.11	0.11		0.11			0.78			0.78	0.78
Clearance Time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	150	203	109		170			1676			2614	1044
v/s Ratio Prot		0.00										
v/s Ratio Perm	0.01		c0.02		0.01			c0.17			0.15	0.00
v/c Ratio	0.07	0.02	0.14		0.10			0.22			0.20	0.00
Uniform Delay, d1	34.2	34.0	34.4		34.3			2.6			2.5	2.2
Progression Factor	1.00	1.00	1.00		1.00			0.65			1.00	1.00
Incremental Delay, d2	0.2	0.0	0.6		0.3			0.3			0.2	0.0
Delay (s)	34.4	34.0	35.0		34.5			2.0			2.7	2.2
Level of Service	C	C	D		C			A			A	A
Approach Delay (s)		35.0			34.5			2.0			2.7	
Approach LOS		C			C			A			A	

Intersection Summary			
HCM Average Control Delay	8.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.21		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	44.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action
21: I-35 SB Ramps & Gardner Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	40	0	150	10	200	0	0	600	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0		5.0		5.0			5.0	5.0
Lane Util. Factor				1.00		1.00		1.00			1.00	1.00
Frt				1.00		0.85		1.00			1.00	0.85
Flt Protected				0.95		1.00		1.00			1.00	1.00
Satd. Flow (prot)				1671		1145		1809			1667	1468
Flt Permitted				0.95		1.00		0.97			1.00	1.00
Satd. Flow (perm)				1671		1145		1762			1667	1468
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	43	0	160	11	213	0	0	638	53
RTOR Reduction (vph)	0	0	0	0	0	143	0	0	0	0	0	12
Lane Group Flow (vph)	0	0	0	43	0	17	0	224	0	0	638	41
Heavy Vehicles (%)	0%	0%	0%	8%	0%	41%	0%	5%	0%	0%	14%	10%
Turn Type				Prot		custom	Perm					Perm
Protected Phases				3				2			6	
Permitted Phases						3	2					6
Actuated Green, G (s)				9.0		9.0		66.0			66.0	66.0
Effective Green, g (s)				9.0		9.0		66.0			66.0	66.0
Actuated g/C Ratio				0.11		0.11		0.78			0.78	0.78
Clearance Time (s)				5.0		5.0		5.0			5.0	5.0
Vehicle Extension (s)				3.0		3.0		3.0			3.0	3.0
Lane Grp Cap (vph)				177		121		1368			1294	1140
v/s Ratio Prot				c0.03							c0.38	
v/s Ratio Perm						0.01		0.13				0.03
v/c Ratio				0.24		0.14		0.16			0.49	0.04
Uniform Delay, d1				34.9		34.5		2.4			3.4	2.2
Progression Factor				1.00		1.00		0.85			0.93	0.67
Incremental Delay, d2				0.7		0.5		0.2			1.3	0.1
Delay (s)				35.6		35.0		2.3			4.5	1.5
Level of Service				D		D		A			A	A
Approach Delay (s)		0.0			35.1			2.3			4.3	
Approach LOS		A			D			A			A	

Intersection Summary			
HCM Average Control Delay	9.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.46		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	42.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action
22: I-35 NB Ramps & Gardner Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	0	10	0	0	0	0	130	180	520	120	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.98						0.92			1.00	
Flt Protected		0.96						1.00			0.96	
Satd. Flow (prot)		1712						1696			1599	
Flt Permitted		0.96						1.00			0.56	
Satd. Flow (perm)		1712						1696			934	
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	88	0	11	0	0	0	0	143	198	571	132	0
RTOR Reduction (vph)	0	6	0	0	0	0	0	36	0	0	0	0
Lane Group Flow (vph)	0	93	0	0	0	0	0	305	0	0	703	0
Heavy Vehicles (%)	4%	0%	10%	0%	0%	0%	0%	5%	2%	17%	2%	0%
Turn Type	Perm									Perm		
Protected Phases		4						2			6	
Permitted Phases	4									6		
Actuated Green, G (s)		5.6						69.4			69.4	
Effective Green, g (s)		5.6						69.4			69.4	
Actuated g/C Ratio		0.07						0.82			0.82	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		113						1385			763	
v/s Ratio Prot								0.18				
v/s Ratio Perm		0.05									c0.75	
v/c Ratio		0.83						0.22			0.92	
Uniform Delay, d1		39.2						1.7			5.8	
Progression Factor		1.00						1.00			0.96	
Incremental Delay, d2		36.7						0.4			16.9	
Delay (s)		76.0						2.1			22.5	
Level of Service		E						A			C	
Approach Delay (s)		76.0			0.0			2.1			22.5	
Approach LOS		E			A			A			C	

Intersection Summary			
HCM Average Control Delay	21.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	71.3%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action
23: E 191st Street & Gardner Rd — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	10	300	0	5	130
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	11	323	0	5	140
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						220
pX, platoon unblocked						
vC, conflicting volume	473	323			323	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	473	323			323	
tC, single (s)	6.4	6.2			4.3	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.4	
p0 queue free %	100	99			100	
cM capacity (veh/h)	551	723			1143	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	11	323	145
Volume Left	0	0	5
Volume Right	11	0	0
cSH	723	1700	1143
Volume to Capacity	0.01	0.19	0.00
Queue Length 95th (ft)	1	0	0
Control Delay (s)	10.1	0.0	0.3
Lane LOS	B		A
Approach Delay (s)	10.1	0.0	0.3
Approach LOS	B		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	25.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action
24: Sunflower Road & US 56 — AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	10	30	0	0	10	320	60	5	90	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	6	13	38	0	0	13	405	76	6	114	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	595	633	114	611	595	443	114			481		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	595	633	114	611	595	443	114			481		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	90	100	100	99			99		
cM capacity (veh/h)	414	394	944	380	414	619	1488			1092		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	25	38	494	120
Volume Left	6	38	13	6
Volume Right	13	0	76	0
cSH	566	380	1488	1092
Volume to Capacity	0.04	0.10	0.01	0.01
Queue Length 95th (ft)	4	8	1	0
Control Delay (s)	11.7	15.5	0.3	0.5
Lane LOS	B	C	A	A
Approach Delay (s)	11.7	15.5	0.3	0.5
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	35.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action
25: US 56 & 4th Street — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	350	50	10	110	10	30
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	449	64	13	141	13	38
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			513		647	481
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			513		647	481
tC, single (s)			4.2		6.5	6.2
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.3
p0 queue free %			99		97	93
cM capacity (veh/h)			1013		418	583

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	513	154	51
Volume Left	0	13	13
Volume Right	64	0	38
cSH	1700	1013	531
Volume to Capacity	0.30	0.01	0.10
Queue Length 95th (ft)	0	1	8
Control Delay (s)	0.0	0.8	12.5
Lane LOS		A	B
Approach Delay (s)	0.0	0.8	12.5
Approach LOS			B

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	31.5%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Proposed Action - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

26: 199th Street & Four Corners Road

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	60	30	20	5	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	6	71	36	24	6	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	60				131	48
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	60				131	48
tC, single (s)	4.3				6.6	6.6
tC, 2 stage (s)						
tF (s)	2.4				3.7	3.7
p0 queue free %	100				99	99
cM capacity (veh/h)	1437				819	923

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	77	60	12
Volume Left	6	0	6
Volume Right	0	24	6
cSH	1437	1700	868
Volume to Capacity	0.00	0.04	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.6	0.0	9.2
Lane LOS	A		A
Approach Delay (s)	0.6	0.0	9.2
Approach LOS			A

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	17.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

27: 199th Street & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	60	20	10	5	20	40	10	230	10	30	60	30
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	67	22	11	6	22	45	11	258	11	34	67	34

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	101	73	281	135
Volume Left (vph)	67	6	11	34
Volume Right (vph)	11	45	11	34
Hadj (s)	0.13	-0.30	0.03	-0.07
Departure Headway (s)	5.1	4.7	4.5	4.6
Degree Utilization, x	0.14	0.10	0.35	0.17
Capacity (veh/h)	642	684	762	734
Control Delay (s)	9.0	8.2	10.0	8.6
Approach Delay (s)	9.0	8.2	10.0	8.6
Approach LOS	A	A	B	A

Intersection Summary			
Delay	9.3		
HCM Level of Service	A		
Intersection Capacity Utilization	37.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

30: US-56 & I-35 NB Loop

AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	360	1420	0	500	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	404	1596	0	562	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked						
vC, conflicting volume			2000		685	202
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			2000		685	202
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			291		386	811

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	202	202	1596	281	281
Volume Left	0	0	0	0	0
Volume Right	0	0	1596	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.12	0.12	0.94	0.17	0.17
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	91.3%	ICU Level of Service	F
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

80: 191st Street & Driveway A

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	5	5	55	80	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	5	60	87	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	65				52	35
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	65				52	35
tC, single (s)	5.1				7.4	7.2
tC, 2 stage (s)						
tF (s)	3.1				4.4	4.2
p0 queue free %	100				88	99
cM capacity (veh/h)	1089				755	815

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	11	65	87	5
Volume Left	5	0	87	0
Volume Right	0	60	0	5
cSH	1089	1700	755	815
Volume to Capacity	0.00	0.04	0.12	0.01
Queue Length 95th (ft)	0	0	10	1
Control Delay (s)	4.2	0.0	10.4	9.4
Lane LOS	A		B	A
Approach Delay (s)	4.2	0.0	10.3	
Approach LOS			B	

Intersection Summary			
Average Delay	5.9		
Intersection Capacity Utilization	15.8%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Proposed Action - AM Peak Hour - Synchro Intersection LOS

81: 191st Street & Driveway B

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	90	100	0	0	0
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	98	109	0	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	109				207	109
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	109				207	109
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	100
cM capacity (veh/h)	1494				786	950

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	98	109	0	0
Volume Left	0	0	0	0
Volume Right	0	0	0	0
cSH	1494	1700	1700	1700
Volume to Capacity	0.00	0.06	0.00	0.00
Queue Length 95th (ft)	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0
Lane LOS			A	A
Approach Delay (s)	0.0	0.0	0.0	
Approach LOS			A	

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	8.6%	ICU Level of Service	A
Analysis Period (min)	15		

82: Driveway C & Waverly Road

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	20	30	30	10	10	20
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	22	33	33	11	11	22
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	98	22	33			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	98	22	33			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	97	98			
cM capacity (veh/h)	888	1061	1592			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	22	33	43	33
Volume Left	22	0	33	0
Volume Right	0	33	0	22
cSH	888	1061	1592	1700
Volume to Capacity	0.02	0.03	0.02	0.02
Queue Length 95th (ft)	2	2	2	0
Control Delay (s)	9.2	8.5	5.5	0.0
Lane LOS	A	A	A	
Approach Delay (s)	8.8		5.5	0.0
Approach LOS	A			

Intersection Summary			
Average Delay	5.5		
Intersection Capacity Utilization	18.9%	ICU Level of Service	A
Analysis Period (min)	15		

84: 191st Street & Driveway E

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	85	55	15	15	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	92	60	16	16	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	76				171	68
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	76				171	68
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				98	99
cM capacity (veh/h)	1536				821	1001

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	98	76	22
Volume Left	5	0	16
Volume Right	0	16	5
cSH	1536	1700	859
Volume to Capacity	0.00	0.04	0.03
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.4	0.0	9.3
Lane LOS	A		A
Approach Delay (s)	0.4	0.0	9.3
Approach LOS			A

Intersection Summary			
Average Delay	1.3		
Intersection Capacity Utilization	18.6%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Proposed Action - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

1: 175th Street & Waverly Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑			↑			↑			↑	
Volume (veh/h)	10	90	5	5	280	80	10	20	5	30	20	20
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	12	108	6	6	337	96	12	24	6	36	24	24
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	434			114			569	581	111	551	536	386
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	434			114			569	581	111	551	536	386
tC, single (s)	4.1			4.1			7.2	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.6	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			100			97	94	99	91	95	96
cM capacity (veh/h)	1137			1487			385	421	947	417	447	667

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	127	440	42	84
Volume Left	12	6	12	36
Volume Right	6	96	6	24
cSH	1137	1487	445	477
Volume to Capacity	0.01	0.00	0.09	0.18
Queue Length 95th (ft)	1	0	8	16
Control Delay (s)	0.9	0.1	13.9	14.2
Lane LOS	A	A	B	B
Approach Delay (s)	0.9	0.1	13.9	14.2
Approach LOS			B	B

Intersection Summary			
Average Delay	2.8		
Intersection Capacity Utilization	33.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

2: US 56 & Gardner Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑			↑↑		↰	↑		↰	↑	
Volume (vph)	20	270	50	210	630	220	60	150	140	140	150	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.98			0.97		1.00	0.93		1.00	0.97	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3268			3369		1770	1694		1736	1766	
Flt Permitted		0.86			0.77		0.62	1.00		0.44	1.00	
Satd. Flow (perm)		2809			2634		1158	1694		808	1766	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	23	310	57	241	724	253	69	172	161	161	172	46
RTOR Reduction (vph)	0	22	0	0	37	0	0	60	0	0	17	0
Lane Group Flow (vph)	0	368	0	0	1181	0	69	273	0	161	201	0
Heavy Vehicles (%)	5%	9%	2%	1%	4%	1%	2%	4%	4%	4%	4%	5%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		27.9			27.9		15.2	15.2		15.2	15.2	
Effective Green, g (s)		27.9			27.9		15.2	15.2		15.2	15.2	
Actuated g/C Ratio		0.51			0.51		0.28	0.28		0.28	0.28	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1430			1341		321	470		224	490	
v/s Ratio Prot								0.16			0.11	
v/s Ratio Perm		0.13			c0.45		0.06			c0.20		
v/c Ratio		0.26			0.88		0.21	0.58		0.72	0.41	
Uniform Delay, d1		7.6			12.0		15.2	17.1		17.9	16.1	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.1			7.1		0.3	1.8		10.5	0.6	
Delay (s)		7.7			19.0		15.6	18.9		28.4	16.7	
Level of Service		A			B		B	B		C	B	
Approach Delay (s)		7.7			19.0			18.3			21.7	
Approach LOS		A			B			B			C	

Intersection Summary			
HCM Average Control Delay	17.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	54.8	Sum of lost time (s)	11.7
Intersection Capacity Utilization	84.5%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

3: US 56 & Elm

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑			↑↑			↑			↑	
Volume (vph)	10	560	20	30	1030	40	20	10	40	60	10	30
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		0.99			0.99			0.92			0.96	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3574			3668			1765			1842	
Flt Permitted		0.93			0.93			0.90			0.81	
Satd. Flow (perm)		3337			3413			1606			1544	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	11	602	22	32	1108	43	22	11	43	65	11	32
RTOR Reduction (vph)	0	2	0	0	3	0	0	36	0	0	27	0
Lane Group Flow (vph)	0	633	0	0	1180	0	0	40	0	0	81	0
Heavy Vehicles (%)	0%	6%	0%	3%	3%	0%	5%	0%	3%	2%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		33.0			33.0			8.2			8.2	
Effective Green, g (s)		33.0			33.0			8.2			8.2	
Actuated g/C Ratio		0.66			0.66			0.16			0.16	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2194			2244			262			252	
v/s Ratio Prot												
v/s Ratio Perm		0.19			c0.35			0.02			c0.05	
v/c Ratio		0.29			0.53			0.15			0.32	
Uniform Delay, d1		3.6			4.5			18.0			18.5	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.1			0.2			0.3			0.7	
Delay (s)		3.7			4.7			18.3			19.3	
Level of Service		A			A			B			B	
Approach Delay (s)		3.7			4.7			18.3			19.3	
Approach LOS		A			A			B			B	

Intersection Summary			
HCM Average Control Delay	5.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	50.2	Sum of lost time (s)	9.0
Intersection Capacity Utilization	66.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

4: US 56 & Mulberry

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑			↑↑			↑			↑	
Volume (vph)	10	660	5	20	1120	30	10	5	20	40	10	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			1.00			0.92			0.98	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3436			3493			1678			1797	
Flt Permitted		0.93			0.94			0.89			0.78	
Satd. Flow (perm)		3213			3282			1509			1444	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	11	710	5	22	1204	32	11	5	22	43	11	11
RTOR Reduction (vph)	0	1	0	0	2	0	0	20	0	0	10	0
Lane Group Flow (vph)	0	725	0	0	1256	0	0	18	0	0	55	0
Heavy Vehicles (%)	0%	5%	0%	0%	3%	0%	0%	0%	5%	0%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		35.8			35.8			5.0			5.0	
Effective Green, g (s)		35.8			35.8			5.0			5.0	
Actuated g/C Ratio		0.72			0.72			0.10			0.10	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2310			2359			152			145	
v/s Ratio Prot												
v/s Ratio Perm		0.23			c0.38			0.01			c0.04	
v/c Ratio		0.31			0.53			0.12			0.38	
Uniform Delay, d1		2.5			3.2			20.4			21.0	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.1			0.2			0.4			1.7	
Delay (s)		2.6			3.4			20.8			22.6	
Level of Service		A			A			C			C	
Approach Delay (s)		2.6			3.4			20.8			22.6	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	4.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	49.8	Sum of lost time (s)	9.0
Intersection Capacity Utilization	60.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

2010 Proposed Action - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

5: US 56 & Moonlight Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↑	↱	↰	↑↑	↱	↰↰	↑↑	↱
Volume (vph)	120	400	220	170	930	520	130	160	50	250	210	90
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1736	3551	1583	1770	3539	1583	1770	3539	1583	3433	3539	1553
Flt Permitted	0.17	1.00	1.00	0.47	1.00	1.00	0.61	1.00	1.00	0.57	1.00	1.00
Satd. Flow (perm)	304	3551	1583	880	3539	1583	1132	3539	1583	2046	3539	1553
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	132	440	242	187	1022	571	143	176	55	275	231	99
RTOR Reduction (vph)	0	0	153	0	0	303	0	0	48	0	0	84
Lane Group Flow (vph)	132	440	89	187	1022	268	143	176	7	275	231	15
Heavy Vehicles (%)	4%	7%	2%	2%	2%	2%	2%	2%	2%	2%	2%	4%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6	8		8	4		4
Actuated Green, G (s)	30.6	25.8	25.8	33.2	27.1	27.1	13.9	9.1	9.1	16.3	10.3	10.3
Effective Green, g (s)	30.6	25.8	25.8	33.2	27.1	27.1	13.9	9.1	9.1	16.3	10.3	10.3
Actuated g/C Ratio	0.44	0.37	0.37	0.47	0.39	0.39	0.20	0.13	0.13	0.23	0.15	0.15
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	231	1309	583	495	1370	613	269	460	206	595	521	229
v/s Ratio Prot	c0.04	0.12		0.03	c0.29		0.04	0.05		c0.04	0.07	
v/s Ratio Perm	0.21		0.06	0.15		0.17	c0.07		0.00	0.07		0.01
v/c Ratio	0.57	0.34	0.15	0.38	0.75	0.44	0.53	0.38	0.03	0.46	0.44	0.06
Uniform Delay, d1	13.1	15.9	14.8	10.8	18.5	15.8	24.5	27.9	26.6	22.4	27.2	25.7
Progression Factor	1.00	1.00	1.00	0.59	0.62	0.52	0.89	0.91	0.75	1.00	1.00	1.00
Incremental Delay, d2	2.1	0.7	0.6	0.2	3.3	2.0	1.0	0.2	0.0	0.2	0.2	0.0
Delay (s)	15.2	16.6	15.3	6.5	14.8	10.2	22.7	25.5	20.0	22.6	27.5	25.7
Level of Service	B	B	B	A	B	B	C	C	B	C	C	C
Approach Delay (s)		16.0			12.5			23.7			25.0	
Approach LOS		B			B			C			C	

Intersection Summary			
HCM Average Control Delay	16.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	16.5
Intersection Capacity Utilization	65.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

6: Old US 56 & US 56 — PM Peak Hour

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations	↰	↱	↑↑	↱	↰	↑↑
Volume (vph)	110	20	600	100	10	1520
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	4.0	5.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1736	1538	3619	1553	1805	3725
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1736	1538	3619	1553	1805	3725
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	113	21	619	103	10	1567
RTOR Reduction (vph)	0	19	0	91	0	0
Lane Group Flow (vph)	113	2	619	12	10	1567
Heavy Vehicles (%)	4%	5%	5%	4%	0%	2%
Turn Type		Perm		custom	Prot	
Protected Phases	8		2	4	1	6
Permitted Phases		8				
Actuated Green, G (s)	8.3	8.3	46.3	8.3	1.4	51.7
Effective Green, g (s)	8.3	8.3	46.3	8.3	1.4	51.7
Actuated g/C Ratio	0.12	0.12	0.66	0.12	0.02	0.74
Clearance Time (s)	5.0	5.0	5.0	5.0	4.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	206	182	2394	184	36	2751
v/s Ratio Prot	c0.07		0.17	0.01	0.01	c0.42
v/s Ratio Perm		0.00				
v/c Ratio	0.55	0.01	0.26	0.07	0.28	0.57
Uniform Delay, d1	29.1	27.2	4.8	27.4	33.8	4.1
Progression Factor	1.00	1.00	0.88	1.73	1.35	0.28
Incremental Delay, d2	3.0	0.0	0.2	0.1	3.4	0.7
Delay (s)	32.1	27.3	4.5	47.5	49.2	1.9
Level of Service	C	C	A	D	D	A
Approach Delay (s)	31.3		10.6			2.2
Approach LOS	C		B			A

Intersection Summary			
HCM Average Control Delay	6.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	54.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

7: US-56 & Cedar Niles — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰↰	↑↑	↱		↑	↱↱	↰	↑	
Volume (vph)	40	1140	160	450	1180	30	120	10	350	30	10	20
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00		1.00	0.88	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85	1.00	0.90	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1805	3689	1599	3502	3689	1615		1816	2842	1805	1710	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.72	1.00	0.66	1.00	
Satd. Flow (perm)	1805	3689	1599	3502	3689	1615		1364	2842	1258	1710	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	45	1281	180	506	1326	34	135	11	393	34	11	22
RTOR Reduction (vph)	0	0	99	0	0	15	0	0	333	0	19	0
Lane Group Flow (vph)	45	1281	81	506	1326	19	0	146	60	34	14	0
Heavy Vehicles (%)	0%	3%	1%	0%	3%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Prot		Perm	Prot		Perm	Perm		Perm	Perm		
Protected Phases	5	2		1	6			8			4	
Permitted Phases			2			6	8		8	4		
Actuated Green, G (s)	4.8	31.5	31.5	12.2	38.9	38.9		10.7	10.7	10.7	10.7	
Effective Green, g (s)	4.8	31.5	31.5	12.2	38.9	38.9		10.7	10.7	10.7	10.7	
Actuated g/C Ratio	0.07	0.45	0.45	0.17	0.56	0.56		0.15	0.15	0.15	0.15	
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0	
Lane Grp Cap (vph)	124	1660	720	610	2050	897		208	434	192	261	
v/s Ratio Prot	0.02	c0.35		c0.14	0.36						0.01	
v/s Ratio Perm			0.05			0.01		c0.11	0.02	0.03		
v/c Ratio	0.36	0.77	0.11	0.83	0.65	0.02		0.70	0.14	0.18	0.06	
Uniform Delay, d1	31.1	16.2	11.2	27.9	10.8	7.0		28.1	25.7	25.8	25.3	
Progression Factor	0.95	1.07	2.16	0.76	1.14	1.79		1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.7	3.5	0.3	5.4	0.9	0.0		8.4	0.1	0.2	0.0	
Delay (s)	30.3	21.0	24.4	26.5	13.2	12.5		36.6	25.7	26.0	25.4	
Level of Service	C	C	C	C	B	B		D	C	C	C	
Approach Delay (s)		21.7			16.8			28.7			25.7	
Approach LOS		C			B			C			C	

Intersection Summary			
HCM Average Control Delay	20.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	15.6
Intersection Capacity Utilization	69.6%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

8: US-56 & I-35 SB Ramps — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↱		↰	↑↑					↰		↱↱
Volume (vph)	0	1320	210	100	460	0	0	0	0	120	0	1200
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					2.5		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		0.98		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3437		1687	3725					1770		2760
Flt Permitted		1.00		0.95	1.00					0.95		1.00
Satd. Flow (perm)		3437		1687	3725					1770		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1389	221	105	484	0	0	0	0	126	0	1263
RTOR Reduction (vph)	0	16	0	0	0	0	0	0	0	0	0	88
Lane Group Flow (vph)	0	1594	0	105	484	0	0	0	0	126	0	1175
Heavy Vehicles (%)	0%	3%	2%	7%	2%	0%	0%	0%	0%	2%	0%	3%
Turn Type				Prot						Prot		custom
Protected Phases		2		1	6					7		5
Permitted Phases												4
Actuated Green, G (s)		43.7		6.4	19.1					7.4		31.0
Effective Green, g (s)		43.7		6.4	19.1					7.4		31.0
Actuated g/C Ratio		0.62		0.09	0.27					0.11		0.44
Clearance Time (s)		5.0		5.0	5.0					2.5		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2146		154	1016					187		1222
v/s Ratio Prot		c0.46		c0.06	0.13					c0.07		c0.43
v/s Ratio Perm												
v/c Ratio		0.74		0.68	0.48					0.67		0.96
Uniform Delay, d1		9.2		30.8	21.3					30.1		18.9
Progression Factor		0.40		0.95	0.82					1.00		1.00
Incremental Delay, d2		1.7		11.0	1.5					9.2		17.3
Delay (s)		5.4		40.3	18.8					39.3		36.2
Level of Service		A		D	B					D		D
Approach Delay (s)		5.4			22.7			0.0			36.5	
Approach LOS		A			C			A			D	

Intersection Summary			
HCM Average Control Delay	20.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	17.5
Intersection Capacity Utilization	67.3%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

9: US-56 & I-35 NB Ramps — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑			✣			✣				
Volume (vph)	0	460	0	0	490	20	80	0	40	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			0.99			0.96				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3762			1830			1612				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3762			1830			1612				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	523	0	0	557	23	91	0	45	0	0	0
RTOR Reduction (vph)	0	0	0	0	2	0	0	28	0	0	0	0
Lane Group Flow (vph)	0	523	0	0	578	0	0	108	0	0	0	0
Heavy Vehicles (%)	0%	1%	0%	0%	3%	10%	6%	0%	15%	0%	0%	0%
Turn Type				Perm			Perm					
Protected Phases		2			6			8				
Permitted Phases				6			8					
Actuated Green, G (s)		51.2			51.2			8.8				
Effective Green, g (s)		51.2			51.2			8.8				
Actuated g/C Ratio		0.73			0.73			0.13				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		2752			1339			203				
v/s Ratio Prot		0.14			c0.32							
v/s Ratio Perm								0.07				
v/c Ratio		0.19			0.43			0.53				
Uniform Delay, d1		2.9			3.7			28.7				
Progression Factor		0.45			1.00			1.00				
Incremental Delay, d2		0.1			1.0			2.7				
Delay (s)		1.5			4.7			31.3				
Level of Service		A			A			C				
Approach Delay (s)		1.5			4.7			31.3			0.0	
Approach LOS		A			A			C			A	

Intersection Summary			
HCM Average Control Delay	6.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

10: Sante Fe & — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰	↱	↑↱		↰	↑↑
Volume (vph)	90	110	240	60	140	460
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.97		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3432		1770	3539
Flt Permitted	0.95	1.00	1.00		0.56	1.00
Satd. Flow (perm)	1770	1583	3432		1036	3539
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	97	118	258	65	151	495
RTOR Reduction (vph)	0	105	17	0	0	0
Lane Group Flow (vph)	97	13	306	0	151	495
Turn Type		Perm			Perm	
Protected Phases	6		8			4
Permitted Phases		6			4	
Actuated Green, G (s)	8.0	8.0	52.0		52.0	52.0
Effective Green, g (s)	8.0	8.0	52.0		52.0	52.0
Actuated g/C Ratio	0.11	0.11	0.74		0.74	0.74
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	202	181	2549		770	2629
v/s Ratio Prot	c0.05		0.09			0.14
v/s Ratio Perm		0.01			c0.15	
v/c Ratio	0.48	0.07	0.12		0.20	0.19
Uniform Delay, d1	29.1	27.7	2.5		2.7	2.7
Progression Factor	1.00	1.00	1.00		0.93	0.89
Incremental Delay, d2	1.8	0.2	0.1		0.5	0.1
Delay (s)	30.8	27.9	2.6		3.1	2.6
Level of Service	C	C	A		A	A
Approach Delay (s)	29.2		2.6			2.7
Approach LOS	C		A			A

Intersection Summary			
HCM Average Control Delay	7.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.23		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	34.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

11: Waverly Road & US 56 — PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↑			↑			↑			↑	
Volume (veh/h)	0	10	10	10	5	10	20	120	0	10	260	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	13	13	13	6	13	25	152	0	13	329	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	576	563	152	579	560	332	335			152		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	576	563	152	579	560	332	335			152		
tC, single (s)	7.1	6.6	6.5	7.2	6.7	6.3	4.1			4.5		
tC, 2 stage (s)												
tF (s)	3.5	4.1	3.6	3.6	4.2	3.4	2.2			2.6		
p0 queue free %	100	97	98	97	98	98	98			99		
cM capacity (veh/h)	409	411	826	389	400	691	1235			1227		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	25	32	177	348
Volume Left	0	13	25	13
Volume Right	13	13	0	6
cSH	549	475	1235	1227
Volume to Capacity	0.05	0.07	0.02	0.01
Queue Length 95th (ft)	4	5	2	1
Control Delay (s)	11.9	13.1	1.3	0.4
Lane LOS	B	B	A	A
Approach Delay (s)	11.9	13.1	1.3	0.4
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.9		
Intersection Capacity Utilization	30.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

12: 183rd Street & Four Corners Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑			↑			↑			↑	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	5	5	0	5	5	5	5	0	5	5	5
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	5	0	5	5	5	5	0	5	5	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	16	11	11	16
Volume Left (vph)	5	0	5	5
Volume Right (vph)	5	5	0	5
Hadj (s)	-0.13	-0.30	0.10	-0.13
Departure Headway (s)	3.8	3.7	4.1	3.8
Degree Utilization, x	0.02	0.01	0.01	0.02
Capacity (veh/h)	925	967	865	927
Control Delay (s)	6.9	6.7	7.1	6.9
Approach Delay (s)	6.9	6.7	7.1	6.9
Approach LOS	A	A	A	A

Intersection Summary			
Delay	6.9		
HCM Level of Service	A		
Intersection Capacity Utilization	15.2%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Proposed Action - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action
13: 183rd Street & US 56 — PM Peak Hour

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	5	5	5	140	270	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	6	6	177	342	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	535	345	348			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	535	345	348			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	99	99	99			
cM capacity (veh/h)	507	702	1222			

Direction, Lane #	SE 1	NE 1	SW 1
Volume Total	13	184	348
Volume Left	6	6	0
Volume Right	6	0	6
cSH	589	1222	1700
Volume to Capacity	0.02	0.01	0.20
Queue Length 95th (ft)	2	0	0
Control Delay (s)	11.2	0.3	0.0
Lane LOS	B	A	
Approach Delay (s)	11.2	0.3	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	24.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action
14: 183rd Street & Waverly Road — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	5	10	10	5	5	10
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	11	11	5	5	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	35	14			16	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	35	14			16	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	99			100	
cM capacity (veh/h)	979	1072			1614	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	16	16	16
Volume Left	5	0	5
Volume Right	11	5	0
cSH	1039	1700	1614
Volume to Capacity	0.02	0.01	0.00
Queue Length 95th (ft)	1	0	0
Control Delay (s)	8.5	0.0	2.4
Lane LOS	A		A
Approach Delay (s)	8.5	0.0	2.4
Approach LOS	A		

Intersection Summary			
Average Delay	3.6		
Intersection Capacity Utilization	15.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action
15: 183rd Street & Gardner Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	20	30	50	30	40	70	270	110	60	240	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.91		1.00	0.91		1.00	0.96		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1752	1696		1770	1687		1787	3316		1770	3401	
Flt Permitted	0.89	1.00		0.89	1.00		0.56	1.00		0.50	1.00	
Satd. Flow (perm)	1640	1696		1656	1687		1055	3316		937	3401	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	34	22	34	56	34	45	79	303	124	67	270	45
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	34	56	0	56	79	0	79	427	0	67	315	0
Heavy Vehicles (%)	3%	0%	3%	2%	3%	3%	1%	5%	2%	2%	4%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	4.5	4.5		4.5	4.5		15.3	15.3		15.3	15.3	
Effective Green, g (s)	4.5	4.5		4.5	4.5		15.3	15.3		15.3	15.3	
Actuated g/C Ratio	0.15	0.15		0.15	0.15		0.51	0.51		0.51	0.51	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	248	256		250	255		542	1703		481	1746	
v/s Ratio Prot		0.03			c0.05			c0.13			0.09	
v/s Ratio Perm	0.02			0.03			0.07			0.07		
v/c Ratio	0.14	0.22		0.22	0.31		0.15	0.25		0.14	0.18	
Uniform Delay, d1	11.0	11.1		11.1	11.3		3.8	4.0		3.8	3.9	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.3	0.4		0.5	0.7		0.1	0.1		0.1	0.0	
Delay (s)	11.2	11.5		11.6	12.0		3.9	4.1		3.9	3.9	
Level of Service	B	B		B	B		A	A		A	A	
Approach Delay (s)		11.4			11.8			4.1			3.9	
Approach LOS		B			B			A			A	

Intersection Summary			
HCM Average Control Delay	5.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.26		
Actuated Cycle Length (s)	29.8	Sum of lost time (s)	10.0
Intersection Capacity Utilization	38.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action
16: Four Corners Road & US 56 — PM Peak Hour

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	0	5	5	150	280	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	0	7	7	197	368	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	579	368	368			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	579	368	368			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	99	99			
cM capacity (veh/h)	478	682	1201			

Direction, Lane #	SB 1	NE 1	SW 1
Volume Total	7	204	368
Volume Left	0	7	0
Volume Right	7	0	0
cSH	682	1201	1700
Volume to Capacity	0.01	0.01	0.22
Queue Length 95th (ft)	1	0	0
Control Delay (s)	10.3	0.3	0.0
Lane LOS	B	A	
Approach Delay (s)	10.3	0.3	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.2		
Intersection Capacity Utilization	24.7%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Proposed Action - PM Peak Hour - Synchro Intersection LOS

17: 191st Street & US 56

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	5	5	5	150	280	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	6	6	6	195	364	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	575	367	370			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	575	367	370			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	99	99	99			
cM capacity (veh/h)	481	683	1199			

Direction, Lane #	SE 1	NE 1	SW 1
Volume Total	13	201	370
Volume Left	6	6	0
Volume Right	6	0	6
cSH	564	1199	1700
Volume to Capacity	0.02	0.01	0.22
Queue Length 95th (ft)	2	0	0
Control Delay (s)	11.5	0.3	0.0
Lane LOS	B	A	
Approach Delay (s)	11.5	0.3	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	25.0%	ICU Level of Service	A
Analysis Period (min)	15		

19: 191st Street & Waverly Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	80	0	5	100	10	5	5	5	10	5	10
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	87	0	5	109	11	5	5	5	11	5	11
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	120			87			247	239	87	242	234	114
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	120			87			247	239	87	242	234	114
tC, single (s)	4.5			4.1			7.1	6.5	6.2	7.1	6.5	6.7
tC, 2 stage (s)												
tF (s)	2.6			2.2			3.5	4.0	3.3	3.5	4.0	3.8
p0 queue free %	99			100			99	99	99	98	99	99
cM capacity (veh/h)	1263			1522			690	657	977	701	662	823

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	98	125	16	27
Volume Left	11	5	5	11
Volume Right	0	11	5	11
cSH	1263	1522	751	736
Volume to Capacity	0.01	0.00	0.02	0.04
Queue Length 95th (ft)	1	0	2	3
Control Delay (s)	0.9	0.3	9.9	10.1
Lane LOS	A	A	A	B
Approach Delay (s)	0.9	0.3	9.9	10.1
Approach LOS			A	B

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	18.1%	ICU Level of Service	A
Analysis Period (min)	15		

20: W 191st Street & Gardner Rd

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	5	100	20	5	20	110	510	20	20	380	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00			0.95			0.95	1.00
Frt	1.00	1.00	0.85		0.94			1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00		0.98			0.99			1.00	1.00
Satd. Flow (prot)	1805	1900	934		1746			3017			3501	1468
Flt Permitted	0.73	1.00	1.00		0.85			0.80			0.91	1.00
Satd. Flow (perm)	1378	1900	934		1523			2432			3203	1468
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	11	5	105	22	5	22	116	537	22	22	400	11
RTOR Reduction (vph)	0	0	94	0	20	0	0	2	0	0	0	3
Lane Group Flow (vph)	11	5	11	0	29	0	0	673	0	0	422	8
Heavy Vehicles (%)	0%	0%	73%	0%	0%	0%	82%	5%	0%	0%	3%	10%
Turn Type	Perm		Perm	Perm			Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	7.1	7.1	7.1		7.1			52.9			52.9	52.9
Effective Green, g (s)	7.1	7.1	7.1		7.1			52.9			52.9	52.9
Actuated g/C Ratio	0.10	0.10	0.10		0.10			0.76			0.76	0.76
Clearance Time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	140	193	95		154			1838			2421	1109
v/s Ratio Prot		0.00										
v/s Ratio Perm	0.01		0.01		c0.02			c0.28			0.13	0.01
v/c Ratio	0.08	0.03	0.11		0.19			0.37			0.17	0.01
Uniform Delay, d1	28.5	28.3	28.6		28.8			2.9			2.4	2.1
Progression Factor	1.00	1.00	1.00		1.00			0.80			1.00	1.00
Incremental Delay, d2	0.2	0.1	0.5		0.6			0.5			0.2	0.0
Delay (s)	28.7	28.4	29.1		29.4			2.8			2.6	2.1
Level of Service	C	C	C		C			A			A	A
Approach Delay (s)		29.0			29.4			2.8			2.6	
Approach LOS		C			C			A			A	

Intersection Summary			
HCM Average Control Delay	6.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.35		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	50.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

21: I-35 SB Ramps & Gardner Rd

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	150	0	480	10	150	0	0	420	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0		5.0		5.0			5.0	5.0
Lane Util. Factor				1.00		1.00		1.00			1.00	1.00
Frt				1.00		0.85		1.00			1.00	0.85
Flt Protected				0.95		1.00		1.00			1.00	1.00
Satd. Flow (prot)				1752		1324		1798			1597	1509
Flt Permitted				0.95		1.00		0.97			1.00	1.00
Satd. Flow (perm)				1752		1324		1755			1597	1509
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	160	0	511	11	160	0	0	447	96
RTOR Reduction (vph)	0	0	0	0	0	411	0	0	0	0	0	33
Lane Group Flow (vph)	0	0	0	160	0	100	0	171	0	0	447	63
Heavy Vehicles (%)	0%	0%	0%	3%	0%	22%	10%	5%	0%	0%	19%	7%
Turn Type				Prot		custom	Perm					Perm
Protected Phases				3				2			6	
Permitted Phases						3	2					6
Actuated Green, G (s)				13.7		13.7		46.3			46.3	46.3
Effective Green, g (s)				13.7		13.7		46.3			46.3	46.3
Actuated g/C Ratio				0.20		0.20		0.66			0.66	0.66
Clearance Time (s)				5.0		5.0		5.0			5.0	5.0
Vehicle Extension (s)				3.0		3.0		3.0			3.0	3.0
Lane Grp Cap (vph)				343		259		1161			1056	998
v/s Ratio Prot				c0.09							c0.28	
v/s Ratio Perm						0.08		0.10				0.04
v/c Ratio				0.47		0.39		0.15			0.42	0.06
Uniform Delay, d1				24.9		24.5		4.4			5.6	4.2
Progression Factor				1.00		1.00		0.78			0.88	0.68
Incremental Delay, d2				1.0		1.0		0.3			1.2	0.1
Delay (s)				25.9		25.4		3.7			6.1	3.0
Level of Service				C		C		A			A	A
Approach Delay (s)		0.0			25.6			3.7			5.6	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM Average Control Delay	15.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	46.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

22: I-35 NB Ramps & Gardner Rd

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	0	20	0	0	0	0	120	40	280	280	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.96						0.97			1.00	
Flt Protected		0.97						1.00			0.98	
Satd. Flow (prot)		1573						1774			1612	
Flt Permitted		0.97						1.00			0.75	
Satd. Flow (perm)		1573						1774			1244	
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	44	0	22	0	0	0	0	132	44	308	308	0
RTOR Reduction (vph)	0	21	0	0	0	0	0	9	0	0	0	0
Lane Group Flow (vph)	0	45	0	0	0	0	0	167	0	0	616	0
Heavy Vehicles (%)	15%	0%	5%	0%	0%	0%	0%	3%	5%	29%	1%	0%
Turn Type	Perm									Perm		
Protected Phases		4						2			6	
Permitted Phases	4									6		
Actuated Green, G (s)		4.2						55.8			55.8	
Effective Green, g (s)		4.2						55.8			55.8	
Actuated g/C Ratio		0.06						0.80			0.80	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		94						1414			992	
v/s Ratio Prot								0.09				
v/s Ratio Perm		0.03									c0.50	
v/c Ratio		0.48						0.12			0.62	
Uniform Delay, d1		31.8						1.6			2.9	
Progression Factor		1.00						1.00			0.85	
Incremental Delay, d2		3.9						0.2			2.8	
Delay (s)		35.7						1.8			5.2	
Level of Service		D						A			A	
Approach Delay (s)		35.7			0.0			1.8			5.2	
Approach LOS		D			A			A			A	

Intersection Summary			
HCM Average Control Delay	6.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	57.3%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

23: E 191st Street & Gardner Rd

PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	5	150	5	10	290
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	5	161	5	11	312
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						220
pX, platoon unblocked						
vC, conflicting volume	497	164			167	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	497	164			167	
tC, single (s)	6.4	6.4			4.2	
tC, 2 stage (s)						
tF (s)	3.5	3.5			2.3	
p0 queue free %	100	99			99	
cM capacity (veh/h)	532	836			1364	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	5	167	323
Volume Left	0	0	11
Volume Right	5	5	0
cSH	836	1700	1364
Volume to Capacity	0.01	0.10	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	9.3	0.0	0.3
Lane LOS	A		A
Approach Delay (s)	9.3	0.0	0.3
Approach LOS	A		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	33.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

24: Sunflower Road & US 56

PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	5	10	30	5	0	10	150	40	0	290	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	6	13	38	6	0	13	190	51	0	367	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	614	636	370	627	614	215	373			241		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	614	636	370	627	614	215	373			241		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	100	98	98	90	98	100	99			100		
cM capacity (veh/h)	399	394	680	370	405	830	1196			1338		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	19	44	253	373
Volume Left	0	38	13	0
Volume Right	13	0	51	6
cSH	547	375	1196	1700
Volume to Capacity	0.03	0.12	0.01	0.22
Queue Length 95th (ft)	3	10	1	0
Control Delay (s)	11.8	15.9	0.5	0.0
Lane LOS	B	C	A	
Approach Delay (s)	11.8	15.9	0.5	0.0
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	34.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

25: US 56 & 4th Street

PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	170	20	30	310	60	20
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	218	26	38	397	77	26
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			244		705	231
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			244		705	231
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		80	97
cM capacity (veh/h)			1335		391	813

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	244	436	103
Volume Left	0	38	77
Volume Right	26	0	26
cSH	1700	1335	449
Volume to Capacity	0.14	0.03	0.23
Queue Length 95th (ft)	0	2	22
Control Delay (s)	0.0	1.0	15.4
Lane LOS		A	C
Approach Delay (s)	0.0	1.0	15.4
Approach LOS			C

Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	42.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2010 Gardner Proposed Action

26: 199th Street & Four Corners Road | PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	30	40	5	10	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	6	36	48	6	12	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	54				98	51
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	54				98	51
tC, single (s)	4.5				6.5	6.6
tC, 2 stage (s)						
tF (s)	2.6				3.6	3.7
p0 queue free %	100				99	99
cM capacity (veh/h)	1340				878	920

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	42	54	18
Volume Left	6	0	12
Volume Right	0	6	6
cSH	1340	1700	891
Volume to Capacity	0.00	0.03	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	1.1	0.0	9.1
Lane LOS	A		A
Approach Delay (s)	1.1	0.0	9.1
Approach LOS			A

Intersection Summary			
Average Delay	1.9		
Intersection Capacity Utilization	15.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2010 Gardner Proposed Action

27: 199th Street & Gardner Road | PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	20	20	10	30	30	10	80	10	30	170	40
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	22	22	22	11	34	34	11	90	11	34	191	45

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	67	79	112	270
Volume Left (vph)	22	11	11	34
Volume Right (vph)	22	34	11	45
Hadj (s)	-0.11	-0.13	0.01	-0.04
Departure Headway (s)	4.8	4.7	4.6	4.4
Degree Utilization, x	0.09	0.10	0.14	0.33
Capacity (veh/h)	686	694	746	792
Control Delay (s)	8.2	8.3	8.3	9.5
Approach Delay (s)	8.2	8.3	8.3	9.5
Approach LOS	A	A	A	A

Intersection Summary			
Delay	8.9		
HCM Level of Service	A		
Intersection Capacity Utilization	31.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2010 Gardner Proposed Action

30: US-56 & I-35 NB Loop | PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	460	980	0	570	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	517	1101	0	640	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked						
vC, conflicting volume			1618		837	258
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1618		837	258
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			408		309	747

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	258	258	1101	320	320
Volume Left	0	0	0	0	0
Volume Right	0	0	1101	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.15	0.15	0.65	0.19	0.19
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	64.0%	ICU Level of Service	C
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2010 Gardner Proposed Action

80: 191st Street & Driveway A | PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	5	5	95	75	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	5	103	82	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	109				73	57
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	109				73	57
tC, single (s)	5.1				7.4	7.2
tC, 2 stage (s)						
tF (s)	3.1				4.4	4.2
p0 queue free %	99				89	99
cM capacity (veh/h)	1043				732	790

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	11	109	82	5
Volume Left	5	0	82	0
Volume Right	0	103	0	5
cSH	1043	1700	732	790
Volume to Capacity	0.01	0.06	0.11	0.01
Queue Length 95th (ft)	0	0	9	1
Control Delay (s)	4.3	0.0	10.5	9.6
Lane LOS	A		B	A
Approach Delay (s)	4.3	0.0	10.5	
Approach LOS			B	

Intersection Summary			
Average Delay	4.6		
Intersection Capacity Utilization	17.0%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Proposed Action - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

81: 191st Street & Driveway B

PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	80	100	0	0	0
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	87	109	0	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	109				196	109
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	109				196	109
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	100
cM capacity (veh/h)	1494				798	950

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	87	109	0	0
Volume Left	0	0	0	0
Volume Right	0	0	0	0
cSH	1700	1700	1700	1700
Volume to Capacity	0.05	0.06	0.00	0.00
Queue Length 95th (ft)	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0
Lane LOS			A	A
Approach Delay (s)	0.0	0.0	0.0	
Approach LOS			A	

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	8.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

82: Driveway C & Waverly Road

PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	5	5	5	10	10	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	5	11	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	35	14	16			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	35	14	16			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	99	99	100			
cM capacity (veh/h)	979	1072	1614			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	5	5	16	16
Volume Left	5	0	5	0
Volume Right	0	5	0	5
cSH	979	1072	1614	1700
Volume to Capacity	0.01	0.01	0.00	0.01
Queue Length 95th (ft)	0	0	0	0
Control Delay (s)	8.7	8.4	2.4	0.0
Lane LOS	A	A	A	
Approach Delay (s)	8.5		2.4	0.0
Approach LOS	A			

Intersection Summary			
Average Delay	3.0		
Intersection Capacity Utilization	15.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action

84: 191st Street & Driveway E

PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	75	100	5	5	0
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	82	109	5	5	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	114				193	111
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	114				193	111
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	100
cM capacity (veh/h)	1488				801	947

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	82	114	5
Volume Left	0	0	5
Volume Right	0	5	0
cSH	1488	1700	801
Volume to Capacity	0.00	0.07	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	0.0	9.5
Lane LOS			A
Approach Delay (s)	0.0	0.0	9.5
Approach LOS			A

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	15.6%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Gardner No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

1: 175th Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	70	330	5	0	60	60	5	90	5	100	30	20
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	84	398	6	0	72	72	6	108	6	120	36	24

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	488	145	120	181
Volume Left (vph)	84	0	6	120
Volume Right (vph)	6	72	6	24
Hadj (s)	0.09	-0.23	0.01	0.13
Departure Headway (s)	5.2	5.4	6.0	6.0
Degree Utilization, x	0.70	0.21	0.20	0.30
Capacity (veh/h)	677	608	524	542
Control Delay (s)	19.2	9.8	10.5	11.5
Approach Delay (s)	19.2	9.8	10.5	11.5
Approach LOS	C	A	B	B

Intersection Summary			
Delay	15.1		
HCM Level of Service	C		
Intersection Capacity Utilization	49.9%	ICU Level of Service	A
Analysis Period (min)	15		

2: US 56 & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	630	70	110	240	120	80	360	220	160	230	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.99			0.96		1.00	0.94		1.00	0.98	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3397			3184		1805	1723		1736	1804	
Flt Permitted		0.87			0.56		0.57	1.00		0.22	1.00	
Satd. Flow (perm)		2974			1803		1079	1723		407	1804	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	57	724	80	126	276	138	92	414	253	184	264	34
RTOR Reduction (vph)	0	13	0	0	57	0	0	32	0	0	8	0
Lane Group Flow (vph)	0	848	0	0	483	0	92	635	0	184	290	0
Heavy Vehicles (%)	2%	5%	1%	7%	9%	6%	0%	4%	4%	4%	4%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		20.1			20.1		28.2	28.2		28.2	28.2	
Effective Green, g (s)		20.1			20.1		28.2	28.2		28.2	28.2	
Actuated g/C Ratio		0.34			0.34		0.47	0.47		0.47	0.47	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		996			604		507	810		191	848	
v/s Ratio Prot								0.37			0.16	
v/s Ratio Perm		c0.29			0.27		0.09			c0.45		
v/c Ratio		0.85			0.80		0.18	0.78		0.96	0.34	
Uniform Delay, d1		18.6			18.1		9.2	13.3		15.4	10.0	
Progression Factor		1.00			0.74		1.00	1.00		1.00	1.00	
Incremental Delay, d2		9.1			10.5		0.2	5.0		54.1	0.2	
Delay (s)		27.7			23.9		9.4	18.3		69.5	10.3	
Level of Service		C			C		A	B		E	B	
Approach Delay (s)		27.7			23.9			17.2			32.9	
Approach LOS		C			C			B			C	

Intersection Summary			
HCM Average Control Delay	24.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	11.7
Intersection Capacity Utilization	95.5%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

3: US 56 & Elm

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	990	10	10	440	50	10	5	30	80	10	30
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			0.98			0.91			0.97	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3615			3493			1799			1857	
Flt Permitted		0.94			0.93			0.94			0.77	
Satd. Flow (perm)		3405			3260			1713			1478	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	22	1065	11	11	473	54	11	5	32	86	11	32
RTOR Reduction (vph)	0	1	0	0	12	0	0	28	0	0	21	0
Lane Group Flow (vph)	0	1097	0	0	526	0	0	20	0	0	108	0
Heavy Vehicles (%)	0%	5%	0%	0%	8%	0%	0%	0%	0%	0%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		42.6			42.6			8.4			8.4	
Effective Green, g (s)		42.6			42.6			8.4			8.4	
Actuated g/C Ratio		0.71			0.71			0.14			0.14	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2418			2315			240			207	
v/s Ratio Prot												
v/s Ratio Perm		c0.32			0.16			0.01			c0.07	
v/c Ratio		0.45			0.23			0.09			0.52	
Uniform Delay, d1		3.7			3.0			22.5			23.9	
Progression Factor		0.50			0.70			1.00			1.00	
Incremental Delay, d2		0.3			0.2			0.2			2.4	
Delay (s)		2.2			2.3			22.6			26.3	
Level of Service		A			A			C			C	
Approach Delay (s)		2.2			2.3			22.6			26.3	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	4.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	60.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

4: US 56 & Mulberry

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	1090	10	10	440	60	5	5	20	100	5	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			0.98			0.91			0.97	
Flt Protected		1.00			1.00			0.99			0.96	
Satd. Flow (prot)		3460			3285			1605			1740	
Flt Permitted		0.92			0.93			0.96			0.76	
Satd. Flow (perm)		3193			3055			1553			1372	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	43	1172	11	11	473	65	5	5	22	108	5	32
RTOR Reduction (vph)	0	1	0	0	14	0	0	19	0	0	19	0
Lane Group Flow (vph)	0	1225	0	0	535	0	0	13	0	0	126	0
Heavy Vehicles (%)	5%	4%	0%	0%	8%	8%	0%	20%	5%	2%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		42.0			42.0			9.0			9.0	
Effective Green, g (s)		42.0			42.0			9.0			9.0	
Actuated g/C Ratio		0.70			0.70			0.15			0.15	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2235			2139			233			206	
v/s Ratio Prot												
v/s Ratio Perm		c0.38			0.18			0.01			c0.09	
v/c Ratio		0.55			0.25			0.06			0.61	
Uniform Delay, d1		4.4			3.3			21.9			23.9	
Progression Factor		0.48			1.00			1.00			1.00	
Incremental Delay, d2		0.9			0.1			0.1			5.3	
Delay (s)		3.0			3.3			22.0			29.2	
Level of Service		A			A			C			C	
Approach Delay (s)		3.0			3.3			22.0			29.2	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	5.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	81.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

2015 Gardner No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)

5: US 56 & Moonlight Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	1040	150	40	330	180	140	130	130	490	170	60
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1752	3654	1568	1752	3282	1583	1770	3539	1538	3433	3505	1568
Flt Permitted	0.52	1.00	1.00	0.13	1.00	1.00	0.63	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	954	3654	1568	237	3282	1583	1181	3539	1538	3433	3505	1568
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	77	1143	165	44	363	198	154	143	143	538	187	66
RTOR Reduction (vph)	0	0	94	0	0	116	0	0	130	0	0	59
Lane Group Flow (vph)	77	1143	71	44	363	82	154	143	13	538	187	7
Heavy Vehicles (%)	3%	4%	3%	3%	10%	2%	2%	2%	5%	2%	3%	3%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	Prot		Perm
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6	8		8			4
Actuated Green, G (s)	43.5	38.6	38.6	40.9	37.3	37.3	23.5	8.2	8.2	16.6	9.5	9.5
Effective Green, g (s)	43.5	38.6	38.6	40.9	37.3	37.3	23.5	8.2	8.2	16.6	9.5	9.5
Actuated g/C Ratio	0.48	0.43	0.43	0.45	0.41	0.41	0.26	0.09	0.09	0.18	0.11	0.11
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	505	1567	672	168	1360	656	409	322	140	633	370	166
v/s Ratio Prot	0.01	c0.31		c0.01	0.11		0.06	0.04		c0.16	c0.05	
v/s Ratio Perm	0.07		0.05	0.11		0.05	0.03		0.01			0.00
v/c Ratio	0.15	0.73	0.11	0.26	0.27	0.13	0.38	0.44	0.09	0.85	0.51	0.04
Uniform Delay, d1	12.6	21.4	15.4	15.7	17.3	16.3	27.7	38.7	37.5	35.5	38.0	36.2
Progression Factor	1.00	1.00	1.00	1.23	0.89	0.80	0.97	0.95	0.91	1.00	1.00	1.00
Incremental Delay, d2	0.1	3.0	0.3	0.3	0.0	0.0	0.2	0.4	0.1	10.0	0.4	0.0
Delay (s)	12.6	24.4	15.7	19.6	15.6	13.0	27.2	37.3	34.1	45.5	38.4	36.2
Level of Service	B	C	B	B	B	B	C	D	C	D	D	D
Approach Delay (s)		22.7			15.0			32.7			43.0	
Approach LOS		C			B			C			D	

Intersection Summary			
HCM Average Control Delay	27.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	11.0
Intersection Capacity Utilization	72.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)

6: Old US 56 & US 56 — AM Peak Hour

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	50	10	1430	240	10	540
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	4.0	5.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1615	3654	1568	1805	3551
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1615	3654	1568	1805	3551
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	52	10	1474	247	10	557
RTOR Reduction (vph)	0	8	0	82	0	0
Lane Group Flow (vph)	52	2	1474	165	10	557
Heavy Vehicles (%)	2%	0%	4%	3%	0%	7%
Turn Type		Perm		custom	Prot	
Protected Phases	8		2	4	1	6
Permitted Phases		8				
Actuated Green, G (s)	13.8	13.8	60.8	13.8	1.4	66.2
Effective Green, g (s)	13.8	13.8	60.8	13.8	1.4	66.2
Actuated g/C Ratio	0.15	0.15	0.68	0.15	0.02	0.74
Clearance Time (s)	5.0	5.0	5.0	5.0	4.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	271	248	2468	240	28	2612
v/s Ratio Prot	0.03		c0.40	c0.11	0.01	c0.16
v/s Ratio Perm		0.00				
v/c Ratio	0.19	0.01	0.60	0.69	0.36	0.21
Uniform Delay, d1	33.2	32.3	7.9	36.1	43.9	3.7
Progression Factor	1.00	1.00	0.51	1.12	1.00	1.00
Incremental Delay, d2	0.3	0.0	0.7	5.5	7.7	0.2
Delay (s)	33.6	32.3	4.8	46.0	51.5	3.9
Level of Service	C	C	A	D	D	A
Approach Delay (s)	33.4		10.7			4.8
Approach LOS	C		B			A

Intersection Summary			
HCM Average Control Delay	9.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	51.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)

7: US-56 & Cedar Niles — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	1460	110	270	1270	70	90	20	510	40	10	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00		1.00	0.88	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85	1.00	0.88	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1805	3725	1615	3433	3689	1615		1825	2842	1752	1606	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.73	1.00	0.68	1.00	
Satd. Flow (perm)	1805	3725	1615	3433	3689	1615		1379	2842	1251	1606	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	56	1640	124	303	1427	79	101	22	573	45	11	45
RTOR Reduction (vph)	0	0	61	0	0	32	0	0	0	0	39	0
Lane Group Flow (vph)	56	1640	63	303	1427	47	0	123	573	45	17	0
Heavy Vehicles (%)	0%	2%	0%	2%	3%	0%	0%	0%	0%	3%	0%	5%
Turn Type	Prot		Perm	Prot		Perm	Perm		pt+ov	Perm		
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases			2			6	8			4		
Actuated Green, G (s)	4.8	38.4	38.4	10.6	44.2	44.2		10.4	25.0	10.4	10.4	
Effective Green, g (s)	4.8	38.4	38.4	10.6	44.2	44.2		10.4	21.0	10.4	10.4	
Actuated g/C Ratio	0.06	0.51	0.51	0.14	0.59	0.59		0.14	0.28	0.14	0.14	
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2		5.2	5.2	
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0		1.0		1.0	1.0	
Lane Grp Cap (vph)	116	1907	827	485	2174	952		191	796	173	223	
v/s Ratio Prot	0.03	c0.44		0.09	0.39				c0.20		0.01	
v/s Ratio Perm			0.04			0.03		0.09		0.04		
v/c Ratio	0.48	0.86	0.08	0.62	0.66	0.05		0.64	0.72	0.26	0.08	
Uniform Delay, d1	33.9	16.0	9.3	30.3	10.3	6.5		30.5	24.3	28.9	28.1	
Progression Factor	1.00	1.00	1.00	0.89	0.85	0.95		1.00	1.00	1.00	1.00	
Incremental Delay, d2	1.2	5.3	0.2	1.4	1.2	0.1		5.5	2.6	0.3	0.1	
Delay (s)	35.1	21.3	9.5	28.4	10.0	6.3		36.0	27.0	29.2	28.2	
Level of Service	D	C	A	C	A	A		D	C	C	C	
Approach Delay (s)		20.9			12.9			28.6			28.6	
Approach LOS		C			B			C			C	

Intersection Summary			
HCM Average Control Delay	19.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	16.8
Intersection Capacity Utilization	78.5%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)

8: US-56 & I-35 SB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1970	50	30	540	0	0	0	0	60	0	1060
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		1.00		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3546		1687	3689					1641		2760
Flt Permitted		1.00		0.95	1.00					0.95		1.00
Satd. Flow (perm)		3546		1687	3689					1641		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2074	53	32	568	0	0	0	0	63	0	1116
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	107
Lane Group Flow (vph)	0	2125	0	32	568	0	0	0	0	63	0	1009
Heavy Vehicles (%)	0%	1%	18%	7%	3%	0%	0%	0%	0%	10%	0%	3%
Turn Type				Prot						custom		custom
Protected Phases		2		1	6							5
Permitted Phases										4		4
Actuated Green, G (s)		53.0		2.8	24.8					4.2		35.2
Effective Green, g (s)		53.0		2.8	24.8					4.2		35.2
Actuated g/C Ratio		0.71		0.04	0.33					0.06		0.47
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2506		63	1220					92		1479
v/s Ratio Prot		c0.60		0.02	c0.15							c0.28
v/s Ratio Perm										0.04		0.08
v/c Ratio		0.85		0.51	0.47					0.68		0.68
Uniform Delay, d1		8.1		35.4	19.9					34.8		15.5
Progression Factor		0.81		1.18	0.84					1.00		1.00
Incremental Delay, d2		2.4		5.4	1.1					19.0		1.3
Delay (s)		8.9		47.3	17.7					53.8		16.8
Level of Service		A		D	B					D		B
Approach Delay (s)		8.9			19.3			0.0			18.8	
Approach LOS		A			B			A			B	

Intersection Summary			
HCM Average Control Delay	13.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	66.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

2015 Gardner No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)
9: US-56 & I-35 NB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	400	0	0	400	140	170	0	100	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			0.97			0.95				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3725			1798			1637				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3725			1798			1637				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	455	0	0	455	159	193	0	114	0	0	0
RTOR Reduction (vph)	0	0	0	0	13	0	0	33	0	0	0	0
Lane Group Flow (vph)	0	455	0	0	601	0	0	274	0	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	2%	8%	0%	5%	0%	0%	0%
Turn Type							Perm					
Protected Phases		2			6			8				
Permitted Phases							8					
Actuated Green, G (s)		47.4			47.4			17.6				
Effective Green, g (s)		47.4			47.4			17.6				
Actuated g/C Ratio		0.63			0.63			0.23				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		2354			1136			384				
v/s Ratio Prot		0.12			c0.33							
v/s Ratio Perm								0.17				
v/c Ratio		0.19			0.53			0.71				
Uniform Delay, d1		5.8			7.6			26.4				
Progression Factor		0.34			1.00			1.00				
Incremental Delay, d2		0.1			1.8			6.2				
Delay (s)		2.1			9.4			32.6				
Level of Service		A			A			C				
Approach Delay (s)		2.1			9.4			32.6			0.0	
Approach LOS		A			A			C			A	

Intersection Summary			
HCM Average Control Delay	12.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	104.3%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)
10: Sante Fe & Moonlight — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	50	110	300	80	140	220
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.97		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3408		1787	3471
Flt Permitted	0.95	1.00	1.00		0.51	1.00
Satd. Flow (perm)	1770	1583	3408		963	3471
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	54	118	323	86	151	237
RTOR Reduction (vph)	0	107	15	0	0	0
Lane Group Flow (vph)	54	11	394	0	151	237
Heavy Vehicles (%)	2%	2%	3%	1%	1%	4%
Turn Type		Perm			Perm	
Protected Phases	6		8			4
Permitted Phases		6			4	
Actuated Green, G (s)	8.5	8.5	71.5		71.5	71.5
Effective Green, g (s)	8.5	8.5	71.5		71.5	71.5
Actuated g/C Ratio	0.09	0.09	0.79		0.79	0.79
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	167	150	2707		765	2758
v/s Ratio Prot	c0.03		0.12			0.07
v/s Ratio Perm		0.01			c0.16	
v/c Ratio	0.32	0.07	0.15		0.20	0.09
Uniform Delay, d1	38.1	37.2	2.2		2.3	2.0
Progression Factor	1.00	1.00	1.00		0.83	0.58
Incremental Delay, d2	1.1	0.2	0.1		0.6	0.1
Delay (s)	39.2	37.4	2.3		2.4	1.2
Level of Service	D	D	A		A	A
Approach Delay (s)	37.9		2.3			1.7
Approach LOS	D		A			A

Intersection Summary			
HCM Average Control Delay	8.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.21		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	36.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)
11: Waverly Road & US 56 — AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	20	0	10	10	10	70	290	0	5	90	10
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	25	0	13	13	13	89	367	0	6	114	13
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	696	684	367	690	677	120	127			367		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	696	684	367	690	677	120	127			367		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.3	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.4	2.2			2.2		
p0 queue free %	100	93	100	96	96	99	94			99		
cM capacity (veh/h)	327	349	683	325	352	910	1453			1203		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	25	38	456	133
Volume Left	0	13	89	6
Volume Right	0	13	0	13
cSH	349	428	1453	1203
Volume to Capacity	0.07	0.09	0.06	0.01
Queue Length 95th (ft)	6	7	5	0
Control Delay (s)	16.1	14.2	2.0	0.4
Lane LOS	C	B	A	A
Approach Delay (s)	16.1	14.2	2.0	0.4
Approach LOS	C	B		

Intersection Summary			
Average Delay	2.9		
Intersection Capacity Utilization	40.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)
12: 183rd Street & Four Corners Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	10	5	5	10	10	10	10	5	5	10	5
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	11	5	5	11	11	11	11	5	5	11	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	22	27	27	22
Volume Left (vph)	5	5	11	5
Volume Right (vph)	5	11	5	5
Hadj (s)	-0.10	-0.20	-0.04	-0.10
Departure Headway (s)	3.9	3.8	4.0	3.9
Degree Utilization, x	0.02	0.03	0.03	0.02
Capacity (veh/h)	898	924	880	900
Control Delay (s)	7.0	6.9	7.1	7.0
Approach Delay (s)	7.0	6.9	7.1	7.0
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.0		
HCM Level of Service	A		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Gardner No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)
13: 183rd Street & US 56 — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	10	0	10	10	5	0	360	10	0	100	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	13	0	13	13	6	0	456	13	0	127	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	604	598	130	598	595	462	133			468		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	604	598	130	598	595	462	133			468		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	97	100	97	97	99	100			100		
cM capacity (veh/h)	399	418	925	407	420	604	1464			1104		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	19	32	468	133
Volume Left	6	13	0	0
Volume Right	0	6	13	6
cSH	412	441	1464	1104
Volume to Capacity	0.05	0.07	0.00	0.00
Queue Length 95th (ft)	4	6	0	0
Control Delay (s)	14.2	13.8	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	14.2	13.8	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	29.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)
14: 183rd Street & Waverly Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	10	5	5	20	20	5	5	5	5	5	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	11	5	5	22	22	5	5	5	5	5	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	43			16			60	68	14	65	60	33
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	43			16			60	68	14	65	60	33
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			99	99	99	99	99	100
cM capacity (veh/h)	1578			1614			934	824	1072	922	832	1047

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	16	49	16	11
Volume Left	0	5	5	5
Volume Right	5	22	5	0
cSH	1578	1614	932	875
Volume to Capacity	0.00	0.00	0.02	0.01
Queue Length 95th (ft)	0	0	1	1
Control Delay (s)	0.0	0.8	8.9	9.2
Lane LOS		A	A	A
Approach Delay (s)	0.0	0.8	8.9	9.2
Approach LOS			A	A

Intersection Summary			
Average Delay	3.1		
Intersection Capacity Utilization	16.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)
15: 183rd Street & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	20	90	130	20	110	30	470	50	40	390	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.88		1.00	0.87		1.00	0.99		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1805	1666		1805	1658		1805	3434		1805	3485	
Flt Permitted	0.95	1.00		0.95	1.00		0.46	1.00		0.37	1.00	
Satd. Flow (perm)	1805	1666		1805	1658		876	3434		709	3485	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	45	22	101	146	22	124	34	528	56	45	438	22
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	45	123	0	146	146	0	34	584	0	45	460	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	4%	0%	0%	3%	0%
Turn Type	Prot			Prot			pm+pt			pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases							2			6		
Actuated Green, G (s)	4.2	8.2		9.8	13.8		30.4	26.9		33.6	28.5	
Effective Green, g (s)	4.2	8.2		9.8	13.8		30.4	26.9		33.6	28.5	
Actuated g/C Ratio	0.06	0.12		0.14	0.20		0.43	0.38		0.48	0.41	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	108	195		253	327		427	1320		420	1419	
v/s Ratio Prot	0.02	c0.07		c0.08	c0.09		0.00	c0.17		c0.01	0.13	
v/s Ratio Perm							0.03			0.04		
v/c Ratio	0.42	0.63		0.58	0.45		0.08	0.44		0.11	0.32	
Uniform Delay, d1	31.7	29.5		28.2	24.7		12.5	16.0		12.3	14.2	
Progression Factor	1.00	1.00		1.00	1.00		1.00	0.84		1.00	1.00	
Incremental Delay, d2	2.6	6.5		3.2	1.0		0.1	1.1		0.1	0.1	
Delay (s)	34.3	36.0		31.3	25.7		12.5	14.5		12.4	14.3	
Level of Service	C	D		C	C		B	B		B	B	
Approach Delay (s)		35.5			28.5			14.4			14.1	
Approach LOS		D			C			B			B	

Intersection Summary			
HCM Average Control Delay	19.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.46		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	50.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)
16: Four Corners Road & US 56 — AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	10	0	10	10	10	360	0	5	100	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	7	7	13	0	13	13	13	474	0	7	132	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	664	645	474	661	645	132	132			474		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	664	645	474	661	645	132	132			474		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	98	100	97	99	99			99		
cM capacity (veh/h)	357	388	595	361	388	923	1466			1099		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	26	26	487	138
Volume Left	7	0	13	7
Volume Right	13	13	0	0
cSH	458	546	1466	1099
Volume to Capacity	0.06	0.05	0.01	0.01
Queue Length 95th (ft)	5	4	1	0
Control Delay (s)	13.3	11.9	0.3	0.4
Lane LOS	B	B	A	A
Approach Delay (s)	13.3	11.9	0.3	0.4
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.3		
Intersection Capacity Utilization	34.6%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Gardner No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

17: 191st Street & US 56

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	10	10	5	0	0	5	0	380	5	0	100	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	13	13	6	0	0	6	0	494	6	0	130	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	636	633	133	643	633	497	136			500		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	636	633	133	643	633	497	136			500		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	97	99	100	100	99	100			100		
cM capacity (veh/h)	389	400	921	377	400	577	1460			1075		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	32	6	500	136
Volume Left	13	0	0	0
Volume Right	6	6	6	6
cSH	445	577	1460	1075
Volume to Capacity	0.07	0.01	0.00	0.00
Queue Length 95th (ft)	6	1	0	0
Control Delay (s)	13.7	11.3	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	13.7	11.3	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	35.0%	ICU Level of Service	A
Analysis Period (min)	15		

18: 191st Street & Four Corners Road

AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	5	10	10	10	20	10
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	11	11	11	22	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	71	16			22	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	71	16			22	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	99			99	
cM capacity (veh/h)	926	1069			1607	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	16	22	33
Volume Left	5	0	22
Volume Right	11	11	0
cSH	1016	1700	1607
Volume to Capacity	0.02	0.01	0.01
Queue Length 95th (ft)	1	0	1
Control Delay (s)	8.6	0.0	4.9
Lane LOS	A		A
Approach Delay (s)	8.6	0.0	4.9
Approach LOS	A		

Intersection Summary			
Average Delay	4.2		
Intersection Capacity Utilization	18.3%	ICU Level of Service	A
Analysis Period (min)	15		

19: 191st Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	20	5	5	10	5	5	5	5	5	5	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	22	5	5	11	5	5	5	5	5	5	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	16			27			68	62	24	68	62	14
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	16			27			68	62	24	68	62	14
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			99	99	99	99	99	99
cM capacity (veh/h)	1614			1600			916	827	1058	915	827	1072

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	33	22	16	16
Volume Left	5	5	5	5
Volume Right	5	5	5	5
cSH	1614	1600	924	927
Volume to Capacity	0.00	0.00	0.02	0.02
Queue Length 95th (ft)	0	0	1	1
Control Delay (s)	1.2	1.8	9.0	9.0
Lane LOS	A	A	A	A
Approach Delay (s)	1.2	1.8	9.0	9.0
Approach LOS			A	A

Intersection Summary			
Average Delay	4.3		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

20: W 188th Street & Gardner Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	5	5	30	10	5	10	10	280	5	5	560	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00			0.95			0.95	1.00
Frt	1.00	1.00	0.85		0.94			1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00		0.98			1.00			1.00	1.00
Satd. Flow (prot)	1805	1900	1568		1760			3390			3538	1346
Flt Permitted	0.91	1.00	1.00		0.87			0.94			0.95	1.00
Satd. Flow (perm)	1727	1900	1568		1553			3180			3374	1346
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	5	5	32	11	5	11	11	295	5	5	589	5
RTOR Reduction (vph)	0	0	30	0	10	0	0	1	0	0	0	1
Lane Group Flow (vph)	5	5	2	0	17	0	0	310	0	0	594	4
Heavy Vehicles (%)	0%	0%	3%	0%	0%	0%	10%	6%	0%	0%	2%	20%
Turn Type	Perm		Perm	Perm			Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	4.4	4.4	4.4		4.4			55.6			55.6	55.6
Effective Green, g (s)	4.4	4.4	4.4		4.4			55.6			55.6	55.6
Actuated g/C Ratio	0.06	0.06	0.06		0.06			0.79			0.79	0.79
Clearance Time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	109	119	99		98			2526			2680	1069
v/s Ratio Prot		0.00										
v/s Ratio Perm	0.00		0.00		c0.01			0.10			c0.18	0.00
v/c Ratio	0.05	0.04	0.02		0.17			0.12			0.22	0.00
Uniform Delay, d1	30.8	30.8	30.8		31.1			1.6			1.8	1.5
Progression Factor	1.00	1.00	1.00		1.00			0.82			0.86	0.87
Incremental Delay, d2	0.2	0.1	0.1		0.8			0.1			0.2	0.0
Delay (s)	31.0	31.0	30.9		31.9			1.4			1.7	1.3
Level of Service	C	C	C		C			A			A	A
Approach Delay (s)		30.9			31.9			1.4			1.7	
Approach LOS		C			C			A			A	

Intersection Summary			
HCM Average Control Delay	3.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.22		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	39.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
21: I-35 SB Ramps & Gardner Rd

2015 No-Action Gardner - (Improved)
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	40	0	70	10	220	0	0	550	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0		5.0		5.0			5.0	5.0
Lane Util. Factor				1.00		1.00		1.00			1.00	1.00
Frt				1.00		0.85		1.00			1.00	0.85
Flt Protected				0.95		1.00		1.00			1.00	1.00
Satd. Flow (prot)				1687		1417		1826			1863	1553
Flt Permitted				0.95		1.00		0.98			1.00	1.00
Satd. Flow (perm)				1687		1417		1787			1863	1553
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	43	0	74	11	234	0	0	585	53
RTOR Reduction (vph)	0	0	0	0	0	67	0	0	0	0	0	12
Lane Group Flow (vph)	0	0	0	43	0	7	0	245	0	0	585	41
Heavy Vehicles (%)	0%	0%	0%	7%	0%	14%	0%	4%	0%	0%	2%	4%
Turn Type				Prot		custom	Perm					Perm
Protected Phases				3				2			6	
Permitted Phases						3	2					6
Actuated Green, G (s)				6.4		6.4		53.6			53.6	53.6
Effective Green, g (s)				6.4		6.4		53.6			53.6	53.6
Actuated g/C Ratio				0.09		0.09		0.77			0.77	0.77
Clearance Time (s)				5.0		5.0		5.0			5.0	5.0
Vehicle Extension (s)				3.0		3.0		3.0			3.0	3.0
Lane Grp Cap (vph)				154		130		1368			1427	1189
v/s Ratio Prot				c0.03							c0.31	
v/s Ratio Perm						0.00		0.14				0.03
v/c Ratio				0.28		0.05		0.18			0.41	0.03
Uniform Delay, d1				29.6		29.0		2.2			2.8	2.0
Progression Factor				1.00		1.00		0.62			0.61	0.02
Incremental Delay, d2				1.0		0.2		0.3			0.9	0.1
Delay (s)				30.6		29.2		1.6			2.6	0.1
Level of Service				C		C		A			A	A
Approach Delay (s)		0.0			29.7			1.6			2.4	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM Average Control Delay	5.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	39.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
22: I-35 NB Ramps & Gardner Rd

2015 No-Action Gardner - (Improved)
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	90	0	20	0	0	0	0	150	210	470	130	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.98						0.92			1.00	
Flt Protected		0.96						1.00			0.96	
Satd. Flow (prot)		1750						1705			1793	
Flt Permitted		0.96						1.00			0.54	
Satd. Flow (perm)		1750						1705			1012	
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	99	0	22	0	0	0	0	165	231	516	143	0
RTOR Reduction (vph)	0	12	0	0	0	0	0	51	0	0	0	0
Lane Group Flow (vph)	0	109	0	0	0	0	0	345	0	0	659	0
Heavy Vehicles (%)	1%	0%	5%	0%	0%	0%	0%	5%	1%	2%	2%	0%
Turn Type	Perm									Perm		
Protected Phases		4						2			6	
Permitted Phases	4									6		
Actuated Green, G (s)		5.6						54.4			54.4	
Effective Green, g (s)		5.6						54.4			54.4	
Actuated g/C Ratio		0.08						0.78			0.78	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		140						1325			786	
v/s Ratio Prot								0.20				
v/s Ratio Perm		0.06									c0.65	
v/c Ratio		0.78						0.26			0.84	
Uniform Delay, d1		31.6						2.2			5.0	
Progression Factor		1.00						1.00			1.17	
Incremental Delay, d2		23.4						0.5			9.9	
Delay (s)		55.0						2.7			15.8	
Level of Service		D						A			B	
Approach Delay (s)		55.0			0.0			2.7			15.8	
Approach LOS		D			A			A			B	

Intersection Summary			
HCM Average Control Delay	15.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	72.3%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
23: E 191st Street & Gardner Rd

2015 No-Action Gardner - (Improved)
AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	10	350	0	5	140
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	11	376	0	5	151
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						220
pX, platoon unblocked						
vC, conflicting volume	538	376			376	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	538	376			376	
tC, single (s)	6.4	6.2			4.3	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.4	
p0 queue free %	100	98			100	
cM capacity (veh/h)	505	675			1090	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	11	376	156
Volume Left	0	0	5
Volume Right	11	0	0
cSH	675	1700	1090
Volume to Capacity	0.02	0.22	0.00
Queue Length 95th (ft)	1	0	0
Control Delay (s)	10.4	0.0	0.3
Lane LOS	B		A
Approach Delay (s)	10.4	0.0	0.3
Approach LOS	B		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	28.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study
24: Sunflower Road & US 56

2015 No-Action Gardner - (Improved)
AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	10	30	0	0	10	380	60	5	110	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	6	13	38	0	0	13	481	76	6	139	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	696	734	139	712	696	519	139			557		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	696	734	139	712	696	519	139			557		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	89	100	100	99			99		
cM capacity (veh/h)	355	345	914	333	362	561	1457			1024		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	25	38	570	146
Volume Left	6	38	13	6
Volume Right	13	0	76	0
cSH	506	333	1457	1024
Volume to Capacity	0.05	0.11	0.01	0.01
Queue Length 95th (ft)	4	10	1	0
Control Delay (s)	12.5	17.2	0.3	0.4
Lane LOS	B	C	A	A
Approach Delay (s)	12.5	17.2	0.3	0.4
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	39.2%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Gardner No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)
25: US 56 & 4th Street — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	400	60	20	130	20	50
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	513	77	26	167	26	64
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			590		769	551
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			590		769	551
tC, single (s)			4.1		6.5	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.6	3.3
p0 queue free %			97		93	88
cM capacity (veh/h)			976		353	534

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	590	192	90
Volume Left	0	26	26
Volume Right	77	0	64
cSH	1700	976	466
Volume to Capacity	0.35	0.03	0.19
Queue Length 95th (ft)	0	2	18
Control Delay (s)	0.0	1.4	14.6
Lane LOS		A	B
Approach Delay (s)	0.0	1.4	14.6
Approach LOS			B

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	35.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)
26: 199th Street & Four Corners Road — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	70	30	20	5	0
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	6	83	36	24	6	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	60				143	48
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	60				143	48
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	100
cM capacity (veh/h)	1557				851	1027

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	89	60	6
Volume Left	6	0	6
Volume Right	0	24	0
cSH	1557	1700	851
Volume to Capacity	0.00	0.04	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.5	0.0	9.3
Lane LOS	A		A
Approach Delay (s)	0.5	0.0	9.3
Approach LOS			A

Intersection Summary			
Average Delay	0.7		
Intersection Capacity Utilization	17.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)
27: 199th Street & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	70	20	10	5	20	50	10	270	10	30	60	40
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	79	22	11	6	22	56	11	303	11	34	67	45

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	112	84	326	146
Volume Left (vph)	79	6	11	34
Volume Right (vph)	11	56	11	45
Hadj (s)	0.11	-0.36	0.03	-0.11
Departure Headway (s)	5.3	4.8	4.6	4.7
Degree Utilization, x	0.16	0.11	0.42	0.19
Capacity (veh/h)	620	662	747	715
Control Delay (s)	9.3	8.5	10.9	8.8
Approach Delay (s)	9.3	8.5	10.9	8.8
Approach LOS	A	A	B	A

Intersection Summary			
Delay	9.9		
HCM Level of Service	A		
Intersection Capacity Utilization	39.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)
30: US-56 & I-35 NB Loop — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	410	1630	0	570	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	461	1831	0	640	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked						
vC, conflicting volume			2292		781	230
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			2292		781	230
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			224		336	778

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	230	230	1831	320	320
Volume Left	0	0	0	0	0
Volume Right	0	0	1831	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.14	0.14	1.08	0.19	0.19
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	104.3%	ICU Level of Service	G
Analysis Period (min)	15		

1: 175th Street & Waverly Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱			↰↑↱			↰↑↱			↰↑↱	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	100	5	5	320	90	10	20	5	40	20	20
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	24	120	6	6	386	108	12	24	6	48	24	24

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	151	500	42	96
Volume Left (vph)	24	6	12	48
Volume Right (vph)	6	108	6	24
Hadj (s)	0.08	-0.07	-0.03	-0.02
Departure Headway (s)	4.9	4.4	5.6	5.4
Degree Utilization, x	0.21	0.61	0.07	0.15
Capacity (veh/h)	683	793	558	586
Control Delay (s)	9.2	14.1	8.9	9.4
Approach Delay (s)	9.2	14.1	8.9	9.4
Approach LOS	A	B	A	A

Intersection Summary			
Delay	12.3		
HCM Level of Service	B		
Intersection Capacity Utilization	37.5%	ICU Level of Service	A
Analysis Period (min)	15		

2: US 56 & Gardner Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↑↱			↰↑↑↱		↰	↑↱		↰	↑↱	
Volume (vph)	30	310	60	250	720	250	70	170	160	160	170	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.98			0.97		1.00	0.93		1.00	0.97	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3325			3390		1787	1694		1736	1773	
Flt Permitted		0.78			0.75		0.54	1.00		0.34	1.00	
Satd. Flow (perm)		2598			2551		1009	1694		627	1773	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	34	356	69	287	828	287	80	195	184	184	195	57
RTOR Reduction (vph)	0	21	0	0	33	0	0	49	0	0	15	0
Lane Group Flow (vph)	0	438	0	0	1369	0	80	330	0	184	237	0
Heavy Vehicles (%)	0%	7%	2%	1%	3%	1%	1%	4%	4%	4%	4%	2%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		37.8			37.8		20.5	20.5		20.5	20.5	
Effective Green, g (s)		37.8			37.8		20.5	20.5		20.5	20.5	
Actuated g/C Ratio		0.54			0.54		0.29	0.29		0.29	0.29	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1403			1378		295	496		184	519	
v/s Ratio Prot								0.19			0.13	
v/s Ratio Perm		0.17			c0.54		0.08			c0.29		
v/c Ratio		0.31			0.99		0.27	0.67		1.00	0.46	
Uniform Delay, d1		8.9			16.0		19.0	21.7		24.7	20.2	
Progression Factor		1.00			0.32		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.6			21.4		0.5	3.4		66.3	0.6	
Delay (s)		9.5			26.5		19.5	25.1		91.1	20.8	
Level of Service		A			C		B	C		F	C	
Approach Delay (s)		9.5			26.5			24.1			50.5	
Approach LOS		A			C			C			D	

Intersection Summary			
HCM Average Control Delay	27.1	HCM Level of Service	C
HCM Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	11.7
Intersection Capacity Utilization	93.6%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

3: US 56 & Elm

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↑↱			↰↑↑↱			↰↑↱			↰↑↱	
Volume (vph)	10	640	20	40	1180	40	20	10	50	70	10	30
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			1.00			0.92			0.96	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3608			3703			1770			1856	
Flt Permitted		0.93			0.91			0.92			0.80	
Satd. Flow (perm)		3362			3382			1652			1524	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	11	688	22	43	1269	43	22	11	54	75	11	32
RTOR Reduction (vph)	0	2	0	0	2	0	0	47	0	0	25	0
Lane Group Flow (vph)	0	719	0	0	1353	0	0	40	0	0	93	0
Heavy Vehicles (%)	0%	5%	0%	3%	2%	0%	4%	0%	2%	1%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		51.9			51.9			9.1			9.1	
Effective Green, g (s)		51.9			51.9			9.1			9.1	
Actuated g/C Ratio		0.74			0.74			0.13			0.13	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2493			2508			215			198	
v/s Ratio Prot												
v/s Ratio Perm		0.21			c0.40			0.02			c0.06	
v/c Ratio		0.29			0.54			0.19			0.47	
Uniform Delay, d1		3.0			3.9			27.1			28.2	
Progression Factor		0.45			0.27			1.00			1.00	
Incremental Delay, d2		0.2			0.2			0.4			1.8	
Delay (s)		1.6			1.2			27.6			30.0	
Level of Service		A			A			C			C	
Approach Delay (s)		1.6			1.2			27.6			30.0	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	3.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	80.0%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

4: US 56 & Mulberry

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↑↱			↰↑↑↱			↰↑↱			↰↑↱	
Volume (vph)	10	760	10	30	1290	40	10	5	20	40	10	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			1.00			0.92			0.96	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3433			3523			1678			1776	
Flt Permitted		0.93			0.92			0.93			0.80	
Satd. Flow (perm)		3201			3259			1583			1467	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	11	817	11	32	1387	43	11	5	22	43	11	22
RTOR Reduction (vph)	0	1	0	0	3	0	0	20	0	0	20	0
Lane Group Flow (vph)	0	838	0	0	1459	0	0	18	0	0	56	0
Heavy Vehicles (%)	0%	5%	0%	0%	2%	0%	0%	0%	5%	0%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		54.5			54.5			6.5			6.5	
Effective Green, g (s)		54.5			54.5			6.5			6.5	
Actuated g/C Ratio		0.78			0.78			0.09			0.09	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2492			2537			147			136	
v/s Ratio Prot												
v/s Ratio Perm		0.26			c0.45			0.01			c0.04	
v/c Ratio		0.34			0.58			0.12			0.41	
Uniform Delay, d1		2.3			3.1			29.1			29.9	
Progression Factor		0.77			0.77			1.00			1.00	
Incremental Delay, d2		0.4			0.2			0.4			2.0	
Delay (s)		2.2			2.6			29.5			32.0	
Level of Service		A			A			C			C	
Approach Delay (s)		2.2			2.6			29.5			32.0	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	3.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	73.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
5: US 56 & Moonlight Road

2015 No-Action Gardner - (Improved)
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	130	450	250	190	1070	600	150	190	60	280	240	110
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3585	1583	1770	3539	1583	1770	3539	1583	3433	3539	1583
Flt Permitted	0.16	1.00	1.00	0.43	1.00	1.00	0.59	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	292	3585	1583	804	3539	1583	1097	3539	1583	3433	3539	1583
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	143	495	275	209	1176	659	165	209	66	308	264	121
RTOR Reduction (vph)	0	0	175	0	0	290	0	0	58	0	0	105
Lane Group Flow (vph)	143	495	100	209	1176	369	165	209	8	308	264	16
Heavy Vehicles (%)	2%	6%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	Prot		Perm
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6	8		8			4
Actuated Green, G (s)	30.3	25.5	25.5	32.7	26.7	26.7	14.2	8.0	8.0	7.5	9.3	9.3
Effective Green, g (s)	30.3	25.5	25.5	32.7	26.7	26.7	14.2	8.0	8.0	7.5	9.3	9.3
Actuated g/C Ratio	0.43	0.36	0.36	0.47	0.38	0.38	0.20	0.11	0.11	0.11	0.13	0.13
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	228	1306	577	458	1350	604	282	404	181	368	470	210
v/s Ratio Prot	c0.04	0.14		0.04	c0.33		0.05	0.06		c0.09	c0.07	
v/s Ratio Perm	0.23		0.06	0.17		0.23	0.07		0.00			0.01
v/c Ratio	0.63	0.38	0.17	0.46	0.87	0.61	0.59	0.52	0.04	0.84	0.56	0.08
Uniform Delay, d1	14.3	16.4	15.1	11.3	20.1	17.5	24.5	29.2	27.6	30.7	28.4	26.6
Progression Factor	1.49	0.83	0.71	0.74	0.96	1.44	0.91	0.94	0.89	1.00	1.00	1.00
Incremental Delay, d2	3.7	0.8	0.6	0.2	6.6	3.7	2.0	0.5	0.0	14.5	0.9	0.1
Delay (s)	24.9	14.4	11.4	8.6	25.9	28.9	24.2	27.8	24.6	45.2	29.4	26.6
Level of Service	C	B	B	A	C	C	C	C	C	D	C	C
Approach Delay (s)		15.1			25.1			26.0			35.9	
Approach LOS		B			C			C			D	

Intersection Summary			
HCM Average Control Delay	24.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	11.0
Intersection Capacity Utilization	70.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
6: Old US 56 & US 56

2015 No-Action Gardner - (Improved)
PM Peak Hour

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	120	20	690	110	10	1740
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	4.0	6.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1736	1553	3654	1553	1805	3725
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1736	1553	3654	1553	1805	3725
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	124	21	711	113	10	1794
RTOR Reduction (vph)	0	19	0	97	0	0
Lane Group Flow (vph)	124	2	711	16	10	1794
Heavy Vehicles (%)	4%	4%	4%	4%	0%	2%
Turn Type		Perm		custom	Prot	
Protected Phases	8		2	4	1	6
Permitted Phases		8				
Actuated Green, G (s)	7.7	7.7	46.9	7.7	1.4	51.3
Effective Green, g (s)	7.7	7.7	46.9	7.7	1.4	51.3
Actuated g/C Ratio	0.11	0.11	0.67	0.11	0.02	0.73
Clearance Time (s)	5.0	5.0	5.0	5.0	4.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	191	171	2448	171	36	2730
v/s Ratio Prot	c0.07		0.19	0.01	0.01	c0.48
v/s Ratio Perm		0.00				
v/c Ratio	0.65	0.01	0.29	0.09	0.28	0.66
Uniform Delay, d1	29.9	27.8	4.7	28.0	33.8	4.8
Progression Factor	1.00	1.00	0.54	2.17	1.00	1.00
Incremental Delay, d2	7.4	0.0	0.3	0.2	4.2	1.3
Delay (s)	37.3	27.8	2.8	61.1	38.0	6.1
Level of Service	D	C	A	E	D	A
Approach Delay (s)	35.9		10.8			6.2
Approach LOS	D		B			A

Intersection Summary			
HCM Average Control Delay	9.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	11.0
Intersection Capacity Utilization	61.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
7: US-56 & Cedar Niles

2015 No-Action Gardner - (Improved)
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	1310	180	520	1350	40	140	20	400	40	10	30
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00		1.00	0.88	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85	1.00	0.89	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1805	3689	1599	3502	3689	1615		1820	2842	1805	1685	
Flt Permitted	0.11	1.00	1.00	0.95	1.00	1.00		0.72	1.00	0.52	1.00	
Satd. Flow (perm)	215	3689	1599	3502	3689	1615		1368	2842	995	1685	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	45	1472	202	584	1517	45	157	22	449	45	11	34
RTOR Reduction (vph)	0	0	110	0	0	16	0	0	18	0	29	0
Lane Group Flow (vph)	45	1472	92	584	1517	29	0	179	431	45	16	0
Heavy Vehicles (%)	0%	3%	1%	0%	3%	0%	0%	0%	0%	0%	0%	0%
Turn Type	pm+pt		Perm	Prot		Perm	Perm		pt+ov	Perm		
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases	2		2			6	8			4		
Actuated Green, G (s)	36.6	36.6	36.6	15.6	51.0	51.0		12.2	31.8	12.2	12.2	
Effective Green, g (s)	36.6	36.6	36.6	15.6	51.0	51.0		12.2	27.8	12.2	12.2	
Actuated g/C Ratio	0.46	0.46	0.46	0.20	0.64	0.64		0.15	0.35	0.15	0.15	
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2		5.2	5.2	
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0		1.0		1.0	1.0	
Lane Grp Cap (vph)	122	1688	732	683	2352	1030		209	988	152	257	
v/s Ratio Prot	0.01	c0.40		c0.17	0.41				0.15		0.01	
v/s Ratio Perm	0.16		0.06			0.02		c0.13		0.05		
v/c Ratio	0.37	0.87	0.13	0.86	0.64	0.03		0.86	0.44	0.30	0.06	
Uniform Delay, d1	15.0	19.6	12.5	31.1	8.9	5.4		33.0	20.1	30.1	29.0	
Progression Factor	1.00	1.00	1.00	0.91	0.86	0.92		1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.7	6.5	0.4	7.3	1.0	0.0		26.6	0.1	0.4	0.0	
Delay (s)	15.7	26.1	12.8	35.7	8.7	5.0		59.6	20.2	30.5	29.0	
Level of Service	B	C	B	D	A	A		E	C	C	C	
Approach Delay (s)		24.3			16.0			31.4			29.8	
Approach LOS		C			B			C			C	

Intersection Summary			
HCM Average Control Delay	21.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	15.6
Intersection Capacity Utilization	77.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
8: US-56 & I-35 SB Ramps

2015 No-Action Gardner - (Improved)
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1510	240	120	530	0	0	0	0	140	0	1380
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		4.0	5.0					5.0		2.5
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		0.98		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3462		1719	3725					1787		2787
Flt Permitted		1.00		0.28	1.00					0.95		1.00
Satd. Flow (perm)		3462		506	3725					1787		2787
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1589	253	126	558	0	0	0	0	147	0	1453
RTOR Reduction (vph)	0	14	0	0	0	0	0	0	0	0	0	40
Lane Group Flow (vph)	0	1828	0	126	558	0	0	0	0	147	0	1413
Heavy Vehicles (%)	0%	2%	3%	5%	2%	0%	0%	0%	0%	1%	0%	2%
Turn Type				pm+pt						custom		custom
Protected Phases		2		1	6							5
Permitted Phases				6						4		4
Actuated Green, G (s)		48.0		20.7	20.7					11.6		46.8
Effective Green, g (s)		48.0		20.7	20.7					11.6		46.8
Actuated g/C Ratio		0.60		0.26	0.26					0.14		0.58
Clearance Time (s)		5.0		4.0	5.0					5.0		2.5
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2077		228	964					259		1717
v/s Ratio Prot		c0.53		0.04	c0.15							c0.36
v/s Ratio Perm				0.10						0.08		0.15
v/c Ratio		0.88		0.55	0.58					0.57		0.82
Uniform Delay, d1		13.6		24.4	25.8					31.9		13.3
Progression Factor		0.63		0.83	0.86					1.00		1.00
Incremental Delay, d2		4.0		2.6	2.3					2.8		3.3
Delay (s)		12.5		22.9	24.5					34.7		16.6
Level of Service		B		C	C					C		B
Approach Delay (s)		12.5			24.2			0.0			18.3	
Approach LOS		B			C			A			B	

Intersection Summary			
HCM Average Control Delay	16.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	74.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

2015 Gardner No Action - (Improved) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)

9: US-56 & I-35 NB Ramps — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	530	0	0	560	20	90	0	40	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			1.00			0.96				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3762			1850			1608				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3762			1850			1608				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	602	0	0	636	23	102	0	45	0	0	0
RTOR Reduction (vph)	0	0	0	0	1	0	0	22	0	0	0	0
Lane Group Flow (vph)	0	602	0	0	658	0	0	125	0	0	0	0
Heavy Vehicles (%)	0%	1%	0%	0%	2%	9%	7%	0%	15%	0%	0%	0%
Turn Type							Perm					
Protected Phases		2			6			8				
Permitted Phases							8					
Actuated Green, G (s)		58.5			58.5			11.5				
Effective Green, g (s)		58.5			58.5			11.5				
Actuated g/C Ratio		0.73			0.73			0.14				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		2751			1353			231				
v/s Ratio Prot		0.16			c0.36							
v/s Ratio Perm								0.08				
v/c Ratio		0.22			0.49			0.54				
Uniform Delay, d1		3.4			4.5			31.8				
Progression Factor		0.45			1.00			1.00				
Incremental Delay, d2		0.1			1.3			2.4				
Delay (s)		1.7			5.7			34.2				
Level of Service		A			A			C				
Approach Delay (s)		1.7			5.7			34.2			0.0	
Approach LOS		A			A			C			A	

Intersection Summary			
HCM Average Control Delay	7.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	72.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)

10: Sante Fe & Moonlight — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	110	130	270	70	160	530
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.97		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3430		1770	3539
Flt Permitted	0.95	1.00	1.00		0.53	1.00
Satd. Flow (perm)	1770	1583	3430		995	3539
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	118	140	290	75	172	570
RTOR Reduction (vph)	0	120	22	0	0	0
Lane Group Flow (vph)	118	20	343	0	172	570
Turn Type		Perm			Perm	
Protected Phases	6		8			4
Permitted Phases		6			4	
Actuated Green, G (s)	10.2	10.2	49.8		49.8	49.8
Effective Green, g (s)	10.2	10.2	49.8		49.8	49.8
Actuated g/C Ratio	0.15	0.15	0.71		0.71	0.71
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	258	231	2440		708	2518
v/s Ratio Prot	c0.07		0.10			0.16
v/s Ratio Perm		0.01			c0.17	
v/c Ratio	0.46	0.09	0.14		0.24	0.23
Uniform Delay, d1	27.4	25.9	3.2		3.5	3.5
Progression Factor	1.00	1.00	1.00		1.14	1.28
Incremental Delay, d2	1.3	0.2	0.1		0.7	0.2
Delay (s)	28.7	26.0	3.4		4.8	4.6
Level of Service	C	C	A		A	A
Approach Delay (s)	27.2		3.4			4.7
Approach LOS	C		A			A

Intersection Summary			
HCM Average Control Delay	8.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.28		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	37.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)

11: Waverly Road & US 56 — PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	10	5	10	5	20	20	140	0	5	300	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	13	6	13	6	25	25	177	0	6	380	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	652	627	177	636	623	383	386			177		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	652	627	177	636	623	383	386			177		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	100	97	99	96	98	96	98			100		
cM capacity (veh/h)	357	393	871	360	394	658	1183			1411		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	19	44	203	392
Volume Left	0	13	25	6
Volume Right	6	25	0	6
cSH	481	494	1183	1411
Volume to Capacity	0.04	0.09	0.02	0.00
Queue Length 95th (ft)	3	7	2	0
Control Delay (s)	12.8	13.0	1.2	0.2
Lane LOS	B	B	A	A
Approach Delay (s)	12.8	13.0	1.2	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	34.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)

12: 183rd Street & Four Corners Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	10	5	0	10	10	5	5	0	5	5	5
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	11	5	0	11	11	5	5	0	5	5	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	22	22	11	16
Volume Left (vph)	5	0	5	5
Volume Right (vph)	5	11	0	5
Hadj (s)	-0.10	-0.30	0.10	-0.13
Departure Headway (s)	3.9	3.7	4.1	3.9
Degree Utilization, x	0.02	0.02	0.01	0.02
Capacity (veh/h)	915	965	855	916
Control Delay (s)	7.0	6.8	7.2	6.9
Approach Delay (s)	7.0	6.8	7.2	6.9
Approach LOS	A	A	A	A

Intersection Summary			
Delay	6.9		
HCM Level of Service	A		
Intersection Capacity Utilization	15.4%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Gardner No Action - (Improved) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)
13: 183rd Street & US 56 — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	10	0	10	10	0	0	160	20	0	310	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	13	0	13	13	0	0	203	25	0	392	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	614	620	392	614	608	215	392			228		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	614	620	392	614	608	215	392			228		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	97	100	97	97	100	100			100		
cM capacity (veh/h)	397	406	661	397	413	830	1177			1352		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	19	25	228	392
Volume Left	6	13	0	0
Volume Right	0	0	25	0
cSH	403	405	1177	1352
Volume to Capacity	0.05	0.06	0.00	0.00
Queue Length 95th (ft)	4	5	0	0
Control Delay (s)	14.4	14.5	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	14.4	14.5	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.0		
Intersection Capacity Utilization	26.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)
14: 183rd Street & Waverly Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	20	5	5	10	20	5	5	5	5	5	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	22	5	5	11	22	5	5	5	5	5	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	33			27			65	68	24	65	60	22
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	33			27			65	68	24	65	60	22
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			99	99	99	99	99	99
cM capacity (veh/h)	1592			1600			922	824	1058	922	832	1061

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	27	38	16	16
Volume Left	0	5	5	5
Volume Right	5	22	5	5
cSH	1592	1600	925	929
Volume to Capacity	0.00	0.00	0.02	0.02
Queue Length 95th (ft)	0	0	1	1
Control Delay (s)	0.0	1.1	9.0	8.9
Lane LOS		A	A	A
Approach Delay (s)	0.0	1.1	9.0	8.9
Approach LOS			A	A

Intersection Summary			
Average Delay	3.4		
Intersection Capacity Utilization	16.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)
15: 183rd Street & Gardner Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	30	30	60	40	50	80	310	120	70	280	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.92		1.00	0.92		1.00	0.96		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1752	1732		1770	1700		1787	3320		1787	3402	
Flt Permitted	0.69	1.00		0.61	1.00		0.53	1.00		0.45	1.00	
Satd. Flow (perm)	1276	1732		1145	1700		999	3320		849	3402	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	34	34	34	67	45	56	90	348	135	79	315	56
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	34	68	0	67	101	0	90	483	0	79	371	0
Heavy Vehicles (%)	3%	0%	3%	2%	3%	2%	1%	5%	2%	1%	4%	2%
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	11.6	8.8		14.4	10.2		33.0	26.4		31.0	25.4	
Effective Green, g (s)	11.6	8.8		14.4	10.2		33.0	26.4		31.0	25.4	
Actuated g/C Ratio	0.18	0.14		0.22	0.16		0.51	0.41		0.48	0.39	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	248	234		294	267		587	1348		486	1329	
v/s Ratio Prot	0.01	0.04		c0.01	c0.06		c0.02	c0.15		0.01	0.11	
v/s Ratio Perm	0.02			0.04			0.06			0.06		
v/c Ratio	0.14	0.29		0.23	0.38		0.15	0.36		0.16	0.28	
Uniform Delay, d1	22.4	25.3		20.5	24.6		8.7	13.4		10.5	13.5	
Progression Factor	1.00	1.00		1.00	1.00		0.78	0.92		1.00	1.00	
Incremental Delay, d2	0.3	0.7		0.4	0.9		0.1	0.7		0.2	0.1	
Delay (s)	22.6	26.0		20.9	25.5		6.9	13.1		10.7	13.7	
Level of Service	C	C		C	C		A	B		B	B	
Approach Delay (s)		24.9			23.6			12.1			13.1	
Approach LOS		C			C			B			B	

Intersection Summary			
HCM Average Control Delay	15.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.28		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	40.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)
16: Four Corners Road & US 56 — PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	5	0	5	5	5	180	5	10	320	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	7	7	7	0	7	7	7	237	7	13	421	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	711	701	240	711	704	421	421			243		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	711	701	240	711	704	421	421			243		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	100	98	99	99			99		
cM capacity (veh/h)	338	360	804	339	358	637	1149			1335		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	20	13	250	434
Volume Left	7	0	7	13
Volume Right	7	7	7	0
cSH	430	459	1149	1335
Volume to Capacity	0.05	0.03	0.01	0.01
Queue Length 95th (ft)	4	2	0	1
Control Delay (s)	13.8	13.1	0.3	0.3
Lane LOS	B	B	A	A
Approach Delay (s)	13.8	13.1	0.3	0.3
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	33.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)

17: 191st Street & US 56 — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	0	0	5	5	0	0	170	0	0	320	10
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	0	0	0	6	6	0	0	221	0	0	416	13
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	646	643	422	643	649	221	429			221		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	646	643	422	643	649	221	429			221		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	98	98	100	100			100		
cM capacity (veh/h)	382	395	636	389	391	824	1142			1360		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	0	13	221	429
Volume Left	0	6	0	0
Volume Right	0	0	0	13
cSH	1700	390	1142	1360
Volume to Capacity	0.00	0.03	0.00	0.00
Queue Length 95th (ft)	0	3	0	0
Control Delay (s)	0.0	14.5	0.0	0.0
Lane LOS	A	B		
Approach Delay (s)	0.0	14.5	0.0	0.0
Approach LOS	A	B		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	27.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)

18: 191st Street & Four Corners Road — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	10	10	10	5	5	5
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	11	11	5	5	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	30	14			16	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	30	14			16	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	99			100	
cM capacity (veh/h)	986	1072			1614	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	22	16	11
Volume Left	11	0	5
Volume Right	11	5	0
cSH	1027	1700	1614
Volume to Capacity	0.02	0.01	0.00
Queue Length 95th (ft)	2	0	0
Control Delay (s)	8.6	0.0	3.6
Lane LOS	A		A
Approach Delay (s)	8.6	0.0	3.6
Approach LOS	A		

Intersection Summary			
Average Delay	4.6		
Intersection Capacity Utilization	14.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)

19: 191st Street & Waverly Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	5	0	5	10	10	5	5	5	10	5	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	0	5	11	11	5	5	5	11	5	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	22			5			52	49	5	52	43	16
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	22			5			52	49	5	52	43	16
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			99	99	99	99	99	99
cM capacity (veh/h)	1607			1629			938	841	1083	938	847	1069

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	11	27	16	22
Volume Left	5	5	5	11
Volume Right	0	11	5	5
cSH	1607	1629	944	941
Volume to Capacity	0.00	0.00	0.02	0.02
Queue Length 95th (ft)	0	0	1	2
Control Delay (s)	3.6	1.5	8.9	8.9
Lane LOS	A	A	A	A
Approach Delay (s)	3.6	1.5	8.9	8.9
Approach LOS			A	A

Intersection Summary			
Average Delay	5.5		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)

20: W 191st Street & Gardner Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	10	30	20	10	20	20	580	20	20	440	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00			0.95			0.95	1.00
Frt	1.00	1.00	0.85		0.95			0.99			1.00	0.85
Flt Protected	0.95	1.00	1.00		0.98			1.00			1.00	1.00
Satd. Flow (prot)	1805	1900	1468		1762			3452			3502	1468
Flt Permitted	0.82	1.00	1.00		0.86			0.94			0.92	1.00
Satd. Flow (perm)	1551	1900	1468		1554			3234			3226	1468
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	11	11	32	22	11	22	21	611	22	22	463	11
RTOR Reduction (vph)	0	0	30	0	20	0	0	2	0	0	0	3
Lane Group Flow (vph)	11	11	2	0	35	0	0	652	0	0	485	8
Heavy Vehicles (%)	0%	0%	10%	0%	0%	0%	5%	4%	0%	0%	3%	10%
Turn Type	Perm		Perm	Perm			Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	4.9	4.9	4.9		4.9			50.1			50.1	50.1
Effective Green, g (s)	4.9	4.9	4.9		4.9			50.1			50.1	50.1
Actuated g/C Ratio	0.08	0.08	0.08		0.08			0.77			0.77	0.77
Clearance Time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	117	143	111		117			2493			2487	1131
v/s Ratio Prot		0.01										
v/s Ratio Perm	0.01		0.00		c0.02			c0.20			0.15	0.01
v/c Ratio	0.09	0.08	0.02		0.30			0.26			0.20	0.01
Uniform Delay, d1	28.0	27.9	27.8		28.4			2.1			2.0	1.7
Progression Factor	1.00	1.00	1.00		1.00			0.83			0.47	0.40
Incremental Delay, d2	0.4	0.2	0.1		1.4			0.2			0.2	0.0
Delay (s)	28.3	28.2	27.9		29.8			2.0			1.1	0.7
Level of Service	C	C	C		C			A			A	A
Approach Delay (s)		28.1			29.8			2.0			1.1	
Approach LOS		C			C			A			A	

Intersection Summary			
HCM Average Control Delay	4.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.26		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	49.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

2015 Gardner No Action - (Improved) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)

21: I-35 SB Ramps & Gardner Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	170	0	450	10	170	0	0	400	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0		5.0		5.0			5.0	5.0
Lane Util. Factor				1.00		1.00		1.00			1.00	1.00
Frt				1.00		0.85		1.00			1.00	0.85
Flt Protected				0.95		1.00		1.00			1.00	1.00
Satd. Flow (prot)				1736		1538		1816			1845	1538
Flt Permitted				0.95		1.00		0.98			1.00	1.00
Satd. Flow (perm)				1736		1538		1778			1845	1538
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	181	0	479	11	181	0	0	426	106
RTOR Reduction (vph)	0	0	0	0	0	383	0	0	0	0	0	38
Lane Group Flow (vph)	0	0	0	181	0	96	0	192	0	0	426	68
Heavy Vehicles (%)	0%	0%	0%	4%	0%	5%	10%	4%	0%	0%	3%	5%
Turn Type				Prot		custom	Perm					Perm
Protected Phases				3				2			6	
Permitted Phases						3	2					6
Actuated Green, G (s)				13.0		13.0		42.0			42.0	42.0
Effective Green, g (s)				13.0		13.0		42.0			42.0	42.0
Actuated g/C Ratio				0.20		0.20		0.65			0.65	0.65
Clearance Time (s)				5.0		5.0		5.0			5.0	5.0
Vehicle Extension (s)				3.0		3.0		3.0			3.0	3.0
Lane Grp Cap (vph)				347		308		1149			1192	994
v/s Ratio Prot				c0.10							c0.23	
v/s Ratio Perm						0.06		0.11				0.04
v/c Ratio				0.52		0.31		0.17			0.36	0.07
Uniform Delay, d1				23.2		22.2		4.6			5.3	4.3
Progression Factor				1.00		1.00		0.79			0.44	0.29
Incremental Delay, d2				1.4		0.6		0.3			0.8	0.1
Delay (s)				24.6		22.8		3.9			3.1	1.4
Level of Service				C		C		A			A	A
Approach Delay (s)		0.0			23.3			3.9			2.8	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM Average Control Delay	12.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	45.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)

22: I-35 NB Ramps & Gardner Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	10	20	0	0	0	0	130	50	240	320	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.97						0.96			1.00	
Flt Protected		0.97						1.00			0.98	
Satd. Flow (prot)		1695						1771			1803	
Flt Permitted		0.97						1.00			0.77	
Satd. Flow (perm)		1695						1771			1419	
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	55	11	22	0	0	0	0	143	55	264	352	0
RTOR Reduction (vph)	0	19	0	0	0	0	0	13	0	0	0	0
Lane Group Flow (vph)	0	69	0	0	0	0	0	185	0	0	616	0
Heavy Vehicles (%)	6%	0%	5%	0%	0%	0%	0%	3%	4%	6%	1%	0%
Turn Type	Perm									Perm		
Protected Phases		4						2			6	
Permitted Phases	4									6		
Actuated Green, G (s)		5.6						49.4			49.4	
Effective Green, g (s)		5.6						49.4			49.4	
Actuated g/C Ratio		0.09						0.76			0.76	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		146						1346			1078	
v/s Ratio Prot								0.10				
v/s Ratio Perm		0.04									c0.43	
v/c Ratio		0.47						0.14			0.57	
Uniform Delay, d1		28.3						2.1			3.3	
Progression Factor		1.00						1.00			0.86	
Incremental Delay, d2		2.4						0.2			2.1	
Delay (s)		30.7						2.3			5.0	
Level of Service		C						A			A	
Approach Delay (s)		30.7			0.0			2.3			5.0	
Approach LOS		C			A			A			A	

Intersection Summary			
HCM Average Control Delay	6.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	58.3%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)

23: E 191st Street & Gardner Rd — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	5	180	5	10	330
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	5	194	5	11	355
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						220
pX, platoon unblocked						
vC, conflicting volume	573	196			199	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	573	196			199	
tC, single (s)	6.4	6.4			4.2	
tC, 2 stage (s)						
tF (s)	3.5	3.5			2.3	
p0 queue free %	100	99			99	
cM capacity (veh/h)	481	801			1327	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	5	199	366
Volume Left	0	0	11
Volume Right	5	5	0
cSH	801	1700	1327
Volume to Capacity	0.01	0.12	0.01
Queue Length 95th (ft)	1	0	1
Control Delay (s)	9.5	0.0	0.3
Lane LOS	A		A
Approach Delay (s)	9.5	0.0	0.3
Approach LOS	A		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	35.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)

24: Sunflower Road & US 56 — PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	5	10	30	5	0	10	180	40	0	380	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	6	13	38	6	0	13	228	51	0	481	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	766	788	484	778	766	253	487			278		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	766	788	484	778	766	253	487			278		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	98	98	87	98	100	99			100		
cM capacity (veh/h)	315	322	587	298	331	790	1086			1296		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	19	44	291	487
Volume Left	0	38	13	0
Volume Right	13	0	51	6
cSH	460	303	1086	1296
Volume to Capacity	0.04	0.15	0.01	0.00
Queue Length 95th (ft)	3	13	1	0
Control Delay (s)	13.2	18.9	0.5	0.0
Lane LOS	B	C	A	
Approach Delay (s)	13.2	18.9	0.5	0.0
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	35.6%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Gardner No Action - (Improved) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)
25: US 56 & 4th Street — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	190	20	60	350	70	40
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	244	26	77	449	90	51
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			269		859	256
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			269		859	256
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			94		71	93
cM capacity (veh/h)			1306		309	787

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	269	526	141
Volume Left	0	77	90
Volume Right	26	0	51
cSH	1700	1306	396
Volume to Capacity	0.16	0.06	0.36
Queue Length 95th (ft)	0	5	39
Control Delay (s)	0.0	1.7	19.0
Lane LOS		A	C
Approach Delay (s)	0.0	1.7	19.0
Approach LOS			C

Intersection Summary			
Average Delay	3.8		
Intersection Capacity Utilization	49.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)
26: 199th Street & Four Corners Road — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	40	50	5	10	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	6	48	60	6	12	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	65				122	62
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	65				122	62
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	99
cM capacity (veh/h)	1549				875	1008

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	54	65	18
Volume Left	6	0	12
Volume Right	0	6	6
cSH	1549	1700	915
Volume to Capacity	0.00	0.04	0.02
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.8	0.0	9.0
Lane LOS	A		A
Approach Delay (s)	0.8	0.0	9.0
Approach LOS			A

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	16.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)
27: 199th Street & Gardner Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	20	20	10	30	40	10	100	10	40	190	50
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	22	22	22	11	34	45	11	112	11	45	213	56

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	67	90	135	315
Volume Left (vph)	22	11	11	45
Volume Right (vph)	22	45	11	56
Hadj (s)	-0.13	-0.23	0.02	-0.04
Departure Headway (s)	4.9	4.8	4.7	4.4
Degree Utilization, x	0.09	0.12	0.18	0.39
Capacity (veh/h)	655	674	729	782
Control Delay (s)	8.4	8.5	8.7	10.2
Approach Delay (s)	8.4	8.5	8.7	10.2
Approach LOS	A	A	A	B

Intersection Summary			
Delay	9.4		
HCM Level of Service	A		
Intersection Capacity Utilization	35.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Gardner - (Improved)
30: US-56 & I-35 NB Loop — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	530	1120	0	650	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	596	1258	0	730	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked						
vC, conflicting volume			1854		961	298
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1854		961	298
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			331		258	704

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	298	298	1258	365	365
Volume Left	0	0	0	0	0
Volume Right	0	0	1258	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.18	0.18	0.74	0.21	0.21
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	72.7%	ICU Level of Service	C
Analysis Period (min)	15		

2015 Gardner IMF Operations - AM Peak Hour - Synchro Intersection LOS

1: 175th Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✣			✣			✣			✣	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	70	330	5	0	60	60	10	100	5	100	30	20
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	84	398	6	0	72	72	12	120	6	120	36	24

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	488	145	139	181
Volume Left (vph)	84	0	12	120
Volume Right (vph)	6	72	6	24
Hadj (s)	0.10	-0.23	0.04	0.13
Departure Headway (s)	5.2	5.4	6.0	6.0
Degree Utilization, x	0.71	0.22	0.23	0.30
Capacity (veh/h)	668	595	522	535
Control Delay (s)	19.9	10.0	10.9	11.6
Approach Delay (s)	19.9	10.0	10.9	11.6
Approach LOS	C	A	B	B

Intersection Summary			
Delay	15.5		
HCM Level of Service	C		
Intersection Capacity Utilization	49.9%	ICU Level of Service	A
Analysis Period (min)	15		

2: US 56 & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱			↰↑↱		↰	↑↱		↰	↑↱	
Volume (vph)	50	640	70	110	250	120	80	370	220	160	230	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.99			0.96		1.00	0.94		1.00	0.98	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3394			3187		1805	1725		1736	1798	
Flt Permitted		0.87			0.55		0.56	1.00		0.22	1.00	
Satd. Flow (perm)		2967			1780		1066	1725		395	1798	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	57	736	80	126	287	138	92	425	253	184	264	34
RTOR Reduction (vph)	0	12	0	0	50	0	0	31	0	0	7	0
Lane Group Flow (vph)	0	861	0	0	501	0	92	647	0	184	291	0
Heavy Vehicles (%)	4%	5%	1%	7%	9%	6%	0%	4%	4%	4%	4%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		22.1			22.1		31.2	31.2		31.2	31.2	
Effective Green, g (s)		22.1			22.1		31.2	31.2		31.2	31.2	
Actuated g/C Ratio		0.34			0.34		0.48	0.48		0.48	0.48	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1009			605		512	828		190	863	
v/s Ratio Prot								0.38			0.16	
v/s Ratio Perm		c0.29			0.28		0.09			c0.47		
v/c Ratio		0.85			0.83		0.18	0.78		0.97	0.34	
Uniform Delay, d1		19.9			19.7		9.6	14.1		16.4	10.5	
Progression Factor		1.00			0.70		1.00	1.00		1.00	1.00	
Incremental Delay, d2		9.1			12.2		0.2	4.8		55.5	0.2	
Delay (s)		29.1			26.1		9.8	18.9		71.9	10.7	
Level of Service		C			C		A	B		E	B	
Approach Delay (s)		29.1			26.1			17.8			34.1	
Approach LOS		C			C			B			C	

Intersection Summary			
HCM Average Control Delay	26.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	11.7
Intersection Capacity Utilization	96.6%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

3: US 56 & Elm

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱			↰↑↱			✣			✣	
Volume (vph)	20	1010	10	10	450	50	10	5	30	80	10	30
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			0.99			0.91			0.97	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3615			3494			1799			1857	
Flt Permitted		0.94			0.93			0.94			0.77	
Satd. Flow (perm)		3404			3260			1715			1478	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	22	1086	11	11	484	54	11	5	32	86	11	32
RTOR Reduction (vph)	0	1	0	0	7	0	0	28	0	0	25	0
Lane Group Flow (vph)	0	1118	0	0	542	0	0	20	0	0	104	0
Heavy Vehicles (%)	0%	5%	0%	0%	8%	0%	0%	0%	0%	0%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		46.9			46.9			9.1			9.1	
Effective Green, g (s)		46.9			46.9			9.1			9.1	
Actuated g/C Ratio		0.72			0.72			0.14			0.14	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2456			2352			240			207	
v/s Ratio Prot												
v/s Ratio Perm		c0.33			0.17			0.01			c0.07	
v/c Ratio		0.46			0.23			0.09			0.50	
Uniform Delay, d1		3.8			3.0			24.3			25.9	
Progression Factor		0.48			0.97			1.00			1.00	
Incremental Delay, d2		0.3			0.0			0.2			1.9	
Delay (s)		2.1			3.0			24.5			27.8	
Level of Service		A			A			C			C	
Approach Delay (s)		2.1			3.0			24.5			27.8	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	4.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.46		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	61.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

4: US 56 & Mulberry

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱			↰↑↱			✣			✣	
Volume (vph)	40	1100	10	10	450	60	5	5	20	100	5	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			0.98			0.91			0.97	
Flt Protected		1.00			1.00			0.99			0.96	
Satd. Flow (prot)		3461			3286			1605			1740	
Flt Permitted		0.92			0.93			0.96			0.76	
Satd. Flow (perm)		3189			3056			1557			1372	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	43	1183	11	11	484	65	5	5	22	108	5	32
RTOR Reduction (vph)	0	1	0	0	13	0	0	19	0	0	17	0
Lane Group Flow (vph)	0	1236	0	0	547	0	0	13	0	0	128	0
Heavy Vehicles (%)	5%	4%	0%	0%	8%	8%	0%	20%	5%	2%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		46.5			46.5			9.5			9.5	
Effective Green, g (s)		46.5			46.5			9.5			9.5	
Actuated g/C Ratio		0.72			0.72			0.15			0.15	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2281			2186			228			201	
v/s Ratio Prot												
v/s Ratio Perm		c0.39			0.18			0.01			c0.09	
v/c Ratio		0.54			0.25			0.06			0.64	
Uniform Delay, d1		4.3			3.2			23.9			26.1	
Progression Factor		0.54			1.00			1.00			1.00	
Incremental Delay, d2		0.9			0.1			0.1			6.5	
Delay (s)		3.2			3.3			24.0			32.6	
Level of Service		A			A			C			C	
Approach Delay (s)		3.2			3.3			24.0			32.6	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	5.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	81.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

5: US 56 & Moonlight Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	1050	150	40	340	180	140	130	130	490	170	60
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1719	3654	1568	1752	3282	1583	1770	3539	1538	3433	3505	1538
Flt Permitted	0.51	1.00	1.00	0.12	1.00	1.00	0.63	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	926	3654	1568	230	3282	1583	1181	3539	1538	3433	3505	1538
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	88	1154	165	44	374	198	154	143	143	538	187	66
RTOR Reduction (vph)	0	0	94	0	0	116	0	0	129	0	0	54
Lane Group Flow (vph)	88	1154	71	44	374	82	154	143	14	538	187	12
Heavy Vehicles (%)	5%	4%	3%	3%	10%	2%	2%	2%	5%	2%	3%	5%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	Prot		Perm
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6	8		8			4
Actuated Green, G (s)	43.5	38.6	38.6	40.9	37.3	37.3	17.3	8.2	8.2	16.6	15.7	15.7
Effective Green, g (s)	43.5	38.6	38.6	40.9	37.3	37.3	17.3	8.2	8.2	16.6	15.7	15.7
Actuated g/C Ratio	0.48	0.43	0.43	0.45	0.41	0.41	0.19	0.09	0.09	0.18	0.17	0.17
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	491	1567	672	165	1360	656	287	322	140	633	611	268
v/s Ratio Prot	0.01	c0.32		c0.01	0.11		0.05	0.04		c0.16	0.05	
v/s Ratio Perm	0.08		0.05	0.11		0.05	c0.05		0.01			0.01
v/c Ratio	0.18	0.74	0.11	0.27	0.28	0.13	0.54	0.44	0.10	0.85	0.31	0.04
Uniform Delay, d1	12.7	21.5	15.4	15.8	17.4	16.3	32.2	38.7	37.5	35.5	32.4	30.9
Progression Factor	1.00	1.00	1.00	0.57	0.72	1.24	1.10	1.07	1.25	1.00	1.00	1.00
Incremental Delay, d2	0.1	3.1	0.3	0.3	0.5	0.4	1.0	0.4	0.1	10.0	0.1	0.0
Delay (s)	12.7	24.6	15.7	9.3	13.0	20.5	36.4	41.7	47.0	45.5	32.5	30.9
Level of Service	B	C	B	A	B	C	D	D	D	D	C	C
Approach Delay (s)		22.8			15.1			41.6			41.2	
Approach LOS		C			B			D			D	

Intersection Summary			
HCM Average Control Delay	28.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	16.5
Intersection Capacity Utilization	72.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

6: Old US 56 & US 56

AM Peak Hour

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	50	10	1430	240	10	540
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	4.0	5.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1615	3654	1568	1805	3551
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1615	3654	1568	1805	3551
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	52	10	1474	247	10	557
RTOR Reduction (vph)	0	8	0	82	0	0
Lane Group Flow (vph)	52	2	1474	165	10	557
Heavy Vehicles (%)	2%	0%	4%	3%	0%	7%
Turn Type		Perm		custom	Prot	
Protected Phases	8		2	4	1	6
Permitted Phases		8				
Actuated Green, G (s)	13.8	13.8	60.8	13.8	1.4	66.2
Effective Green, g (s)	13.8	13.8	60.8	13.8	1.4	66.2
Actuated g/C Ratio	0.15	0.15	0.68	0.15	0.02	0.74
Clearance Time (s)	5.0	5.0	5.0	5.0	4.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	271	248	2468	240	28	2612
v/s Ratio Prot	0.03		c0.40	c0.11	0.01	c0.16
v/s Ratio Perm		0.00				
v/c Ratio	0.19	0.01	0.60	0.69	0.36	0.21
Uniform Delay, d1	33.2	32.3	7.9	36.1	43.9	3.7
Progression Factor	1.00	1.00	0.55	1.52	1.37	0.37
Incremental Delay, d2	0.3	0.0	0.7	5.5	6.2	0.2
Delay (s)	33.6	32.3	5.1	60.2	66.2	1.5
Level of Service	C	C	A	E	E	A
Approach Delay (s)	33.4		13.0			2.7
Approach LOS	C		B			A

Intersection Summary			
HCM Average Control Delay	11.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	51.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

7: US-56 & Cedar Niles

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	1470	110	270	1270	70	90	20	510	40	10	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00		1.00	0.88	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85	1.00	0.88	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1805	3725	1615	3433	3689	1615		1825	2842	1752	1606	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.73	1.00	0.65	1.00	
Satd. Flow (perm)	1805	3725	1615	3433	3689	1615		1379	2842	1194	1606	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	56	1652	124	303	1427	79	101	22	573	45	11	45
RTOR Reduction (vph)	0	0	54	0	0	30	0	0	0	0	39	0
Lane Group Flow (vph)	56	1652	70	303	1427	49	0	123	573	45	17	0
Heavy Vehicles (%)	0%	2%	0%	2%	3%	0%	0%	0%	0%	3%	0%	5%
Turn Type	Prot		Perm	Prot		Perm	Perm		pt+ov	Perm		
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases			2			6	8			4		
Actuated Green, G (s)	6.4	50.8	50.8	11.8	56.2	56.2		11.8	27.6	11.8	11.8	
Effective Green, g (s)	6.4	50.8	50.8	11.8	56.2	56.2		11.8	23.6	11.8	11.8	
Actuated g/C Ratio	0.07	0.56	0.56	0.13	0.62	0.62		0.13	0.26	0.13	0.13	
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2		5.2	5.2	
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0		1.0		1.0	1.0	
Lane Grp Cap (vph)	128	2103	912	450	2304	1008		181	745	157	211	
v/s Ratio Prot	0.03	c0.44		0.09	0.39				c0.20		0.01	
v/s Ratio Perm			0.04			0.03		0.09		0.04		
v/c Ratio	0.44	0.79	0.08	0.67	0.62	0.05		0.68	0.77	0.29	0.08	
Uniform Delay, d1	40.1	15.3	8.9	37.3	10.3	6.5		37.3	30.7	35.3	34.3	
Progression Factor	1.14	0.51	0.33	0.82	0.55	0.64		1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.8	2.8	0.1	2.4	1.0	0.1		7.7	4.3	0.4	0.1	
Delay (s)	46.5	10.6	3.1	32.9	6.7	4.3		45.0	35.0	35.7	34.4	
Level of Service	D	B	A	C	A	A		D	D	D	C	
Approach Delay (s)		11.2			11.0			36.8			35.0	
Approach LOS		B			B			D			C	

Intersection Summary			
HCM Average Control Delay	15.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	16.8
Intersection Capacity Utilization	78.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

8: US-56 & I-35 SB Ramps

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1970	50	30	540	0	0	0	0	60	0	1060
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		1.00		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3546		1641	3689					1641		2760
Flt Permitted		1.00		0.95	1.00					0.95		1.00
Satd. Flow (perm)		3546		1641	3689					1641		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2074	53	32	568	0	0	0	0	63	0	1116
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	2125	0	32	568	0	0	0	0	63	0	1116
Heavy Vehicles (%)	0%	1%	18%	10%	3%	0%	0%	0%	0%	10%	0%	3%
Turn Type				Prot						Prot		custom
Protected Phases		2		1	6					7		5
Permitted Phases												4
Actuated Green, G (s)		65.1		4.2	26.8					5.7		42.5
Effective Green, g (s)		65.1		4.2	26.8					5.7		42.5
Actuated g/C Ratio		0.72		0.05	0.30					0.06		0.47
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2565		77	1099					104		1303
v/s Ratio Prot		c0.60		0.02	c0.15					c0.04		0.40
v/s Ratio Perm												
v/c Ratio		0.83		0.42	0.52					0.61		0.86
Uniform Delay, d1		8.6		41.7	26.2					41.1		21.0
Progression Factor		0.56		0.98	0.92					1.00		1.00
Incremental Delay, d2		2.2		3.1	1.5					9.6		5.8
Delay (s)		7.0		44.1	25.6					50.6		26.8
Level of Service		A		D	C					D		C
Approach Delay (s)		7.0			26.6			0.0			28.1	
Approach LOS		A			C			A			C	

Intersection Summary			
HCM Average Control Delay	16.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	66.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

2015 Gardner IMF Operations - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study
9: US-56 & I-35 NB Ramps

2015 Gardner Proposed Action
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	400	0	0	400	140	170	0	110	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			0.97			0.95				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3725			1798			1629				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3725			1798			1629				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	455	0	0	455	159	193	0	125	0	0	0
RTOR Reduction (vph)	0	0	0	0	11	0	0	31	0	0	0	0
Lane Group Flow (vph)	0	455	0	0	603	0	0	287	0	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	2%	8%	0%	6%	0%	0%	0%
Turn Type							Perm					
Protected Phases		2			6			8				
Permitted Phases							8					
Actuated Green, G (s)		59.0			59.0			21.0				
Effective Green, g (s)		59.0			59.0			21.0				
Actuated g/C Ratio		0.66			0.66			0.23				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		2442			1179			380				
v/s Ratio Prot		0.12			c0.34							
v/s Ratio Perm								0.18				
v/c Ratio		0.19			0.51			0.76				
Uniform Delay, d1		6.1			8.0			32.1				
Progression Factor		0.55			1.00			1.00				
Incremental Delay, d2		0.1			1.6			8.3				
Delay (s)		3.4			9.6			40.4				
Level of Service		A			A			D				
Approach Delay (s)		3.4			9.6			40.4			0.0	
Approach LOS		A			A			D			A	

Intersection Summary			
HCM Average Control Delay	14.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	104.3%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
10: Sante Fe & Moonlight

2015 Gardner Proposed Action
AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	50	110	300	80	140	220
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.97		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3408		1787	3471
Flt Permitted	0.95	1.00	1.00		0.51	1.00
Satd. Flow (perm)	1770	1583	3408		963	3471
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	54	118	323	86	151	237
RTOR Reduction (vph)	0	107	15	0	0	0
Lane Group Flow (vph)	54	11	394	0	151	237
Heavy Vehicles (%)	2%	2%	3%	1%	1%	4%
Turn Type		Perm			Perm	
Protected Phases	6		8			4
Permitted Phases		6			4	
Actuated Green, G (s)	8.5	8.5	71.5		71.5	71.5
Effective Green, g (s)	8.5	8.5	71.5		71.5	71.5
Actuated g/C Ratio	0.09	0.09	0.79		0.79	0.79
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	167	150	2707		765	2758
v/s Ratio Prot	c0.03		0.12			0.07
v/s Ratio Perm		0.01			c0.16	
v/c Ratio	0.32	0.07	0.15		0.20	0.09
Uniform Delay, d1	38.1	37.2	2.2		2.3	2.0
Progression Factor	1.00	1.00	1.00		0.60	0.42
Incremental Delay, d2	1.1	0.2	0.1		0.6	0.1
Delay (s)	39.2	37.4	2.3		1.9	0.9
Level of Service	D	D	A		A	A
Approach Delay (s)	37.9		2.3			1.3
Approach LOS	D		A			A

Intersection Summary			
HCM Average Control Delay	8.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.21		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	36.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
11: Waverly Road & US 56

2015 Gardner Proposed Action
AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	30	20	10	10	10	70	290	5	20	90	10
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	38	25	13	13	13	89	367	6	25	114	13
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	737	725	370	763	722	120	127			373		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	737	725	370	763	722	120	127			373		
tC, single (s)	7.1	6.5	6.4	7.1	6.6	6.3	4.1			4.2		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.5	3.5	4.1	3.4	2.2			2.3		
p0 queue free %	98	88	96	95	96	99	94			98		
cM capacity (veh/h)	302	322	637	265	315	910	1453			1117		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	70	38	462	152
Volume Left	6	13	89	25
Volume Right	25	13	6	13
cSH	389	373	1453	1117
Volume to Capacity	0.18	0.10	0.06	0.02
Queue Length 95th (ft)	16	8	5	2
Control Delay (s)	16.2	15.7	1.9	1.6
Lane LOS	C	C	A	A
Approach Delay (s)	16.2	15.7	1.9	1.6
Approach LOS	C	C		

Intersection Summary			
Average Delay	4.0		
Intersection Capacity Utilization	36.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study
12: 183rd Street & Four Corners Road

2015 Gardner Proposed Action
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	10	5	5	10	10	10	10	5	5	10	5
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	11	5	5	11	11	11	11	5	5	11	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	22	27	27	22
Volume Left (vph)	5	5	11	5
Volume Right (vph)	5	11	5	5
Hadj (s)	-0.10	-0.20	-0.04	-0.10
Departure Headway (s)	3.9	3.8	4.0	3.9
Degree Utilization, x	0.02	0.03	0.03	0.02
Capacity (veh/h)	898	924	880	900
Control Delay (s)	7.0	6.9	7.1	7.0
Approach Delay (s)	7.0	6.9	7.1	7.0
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.0		
HCM Level of Service	A		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Gardner IMF Operations - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action
13: 183rd Street & US 56 — AM Peak Hour

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	5	0	0	360	100	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	0	0	456	127	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	585	130	133			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	585	130	133			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	99	100	100			
cM capacity (veh/h)	476	925	1464			

Direction, Lane #	SE 1	NE 1	SW 1
Volume Total	6	456	133
Volume Left	6	0	0
Volume Right	0	0	6
cSH	476	1464	1700
Volume to Capacity	0.01	0.00	0.08
Queue Length 95th (ft)	1	0	0
Control Delay (s)	12.7	0.0	0.0
Lane LOS	B		
Approach Delay (s)	12.7	0.0	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	28.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action
14: 183rd Street & Waverly Road — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	20	20	30	20	5	30
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	22	22	33	22	5	33
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	87	43			54	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	87	43			54	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	98	98			100	
cM capacity (veh/h)	916	1033			1564	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	43	54	38
Volume Left	22	0	5
Volume Right	22	22	0
cSH	971	1700	1564
Volume to Capacity	0.04	0.03	0.00
Queue Length 95th (ft)	4	0	0
Control Delay (s)	8.9	0.0	1.1
Lane LOS	A		A
Approach Delay (s)	8.9	0.0	1.1
Approach LOS	A		

Intersection Summary			
Average Delay	3.1		
Intersection Capacity Utilization	15.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action
15: 183rd Street & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	20	100	130	20	110	40	480	50	40	400	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	2.5	2.5		2.5	2.5		2.5	2.5		2.5	2.5	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.87		1.00	0.87		1.00	0.99		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1805	1662		1805	1658		1805	3435		1805	3485	
Flt Permitted	0.48	1.00		0.53	1.00		0.46	1.00		0.39	1.00	
Satd. Flow (perm)	913	1662		1016	1658		872	3435		745	3485	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	56	22	112	146	22	124	45	539	56	45	449	22
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	56	134	0	146	146	0	45	595	0	45	471	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	4%	0%	0%	3%	0%
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	12.9	9.6		16.9	11.6		45.1	41.8		45.1	41.8	
Effective Green, g (s)	12.9	9.6		16.9	11.6		45.1	41.8		45.1	41.8	
Actuated g/C Ratio	0.18	0.14		0.24	0.17		0.64	0.60		0.64	0.60	
Clearance Time (s)	2.5	2.5		2.5	2.5		2.5	2.5		2.5	2.5	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	210	228		305	275		606	2051		530	2081	
v/s Ratio Prot	0.01	c0.08		c0.04	0.09		0.00	c0.17		c0.00	0.14	
v/s Ratio Perm	0.04			0.08			0.04			0.05		
v/c Ratio	0.27	0.59		0.48	0.53		0.07	0.29		0.08	0.23	
Uniform Delay, d1	26.7	28.3		24.8	26.7		4.6	6.9		4.6	6.6	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.7	3.8		1.2	2.0		0.1	0.4		0.1	0.1	
Delay (s)	27.4	32.2		26.0	28.7		4.6	7.2		4.7	6.6	
Level of Service	C	C		C	C		A	A		A	A	
Approach Delay (s)		30.8			27.3			7.0			6.5	
Approach LOS		C			C			A			A	

Intersection Summary			
HCM Average Control Delay	13.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.35		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	45.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action
16: Four Corners Road & US 56 — AM Peak Hour

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	0	10	10	360	100	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	0	13	13	474	132	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	632	132	132			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	632	132	132			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	99	99			
cM capacity (veh/h)	444	923	1466			

Direction, Lane #	SB 1	NE 1	SW 1
Volume Total	13	487	132
Volume Left	0	13	0
Volume Right	13	0	0
cSH	923	1466	1700
Volume to Capacity	0.01	0.01	0.08
Queue Length 95th (ft)	1	1	0
Control Delay (s)	9.0	0.3	0.0
Lane LOS	A	A	
Approach Delay (s)	9.0	0.3	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	36.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action
17: 191st Street & US 56 — AM Peak Hour

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	10	5	0	380	100	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	13	6	0	494	130	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	627	133	136			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	627	133	136			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	99	100			
cM capacity (veh/h)	451	921	1460			

Direction, Lane #	SE 1	NE 1	SW 1
Volume Total	19	494	136
Volume Left	13	0	0
Volume Right	6	0	6
cSH	543	1460	1700
Volume to Capacity	0.04	0.00	0.08
Queue Length 95th (ft)	3	0	0
Control Delay (s)	11.9	0.0	0.0
Lane LOS	B		
Approach Delay (s)	11.9	0.0	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	30.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action
19: 191st Street & Waverly Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	130	5	5	80	40	5	5	5	40	5	10
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	141	5	5	87	43	5	5	5	43	5	11
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	130			147			299	307	144	293	288	109
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	130			147			299	307	144	293	288	109
tC, single (s)	4.6			4.1			7.1	6.5	6.2	7.1	6.5	6.5
tC, 2 stage (s)												
tF (s)	2.7			2.2			3.5	4.0	3.3	3.5	4.0	3.6
p0 queue free %	99			100			99	99	99	93	99	99
cM capacity (veh/h)	1206			1448			639	602	909	648	617	874

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	158	136	16	60
Volume Left	11	5	5	43
Volume Right	5	43	5	11
cSH	1206	1448	693	677
Volume to Capacity	0.01	0.00	0.02	0.09
Queue Length 95th (ft)	1	0	2	7
Control Delay (s)	0.6	0.3	10.3	10.8
Lane LOS	A	A	B	B
Approach Delay (s)	0.6	0.3	10.3	10.8
Approach LOS			B	B

Intersection Summary			
Average Delay	2.6		
Intersection Capacity Utilization	23.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action
20: W 188th Street & Gardner Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	5	160	10	5	10	110	280	5	5	560	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00			0.95			0.95	1.00
Frt	1.00	1.00	0.85		0.94			1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00		0.98			0.99			1.00	1.00
Satd. Flow (prot)	1805	1900	1022		1760			2965			3538	1346
Flt Permitted	0.74	1.00	1.00		0.88			0.68			0.95	1.00
Satd. Flow (perm)	1405	1900	1022		1586			2030			3371	1346
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	11	5	168	11	5	11	116	295	5	5	589	5
RTOR Reduction (vph)	0	0	154	0	10	0	0	0	0	0	0	1
Lane Group Flow (vph)	11	5	14	0	17	0	0	416	0	0	594	4
Heavy Vehicles (%)	0%	0%	58%	0%	0%	0%	56%	6%	0%	0%	2%	20%
Turn Type	Perm		Perm	Perm			Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	10.0	10.0	10.0		10.0			100.0			100.0	100.0
Effective Green, g (s)	10.0	10.0	10.0		10.0			100.0			100.0	100.0
Actuated g/C Ratio	0.08	0.08	0.08		0.08			0.83			0.83	0.83
Clearance Time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	117	158	85		132			1692			2809	1122
v/s Ratio Prot		0.00										
v/s Ratio Perm	0.01		c0.01		0.01			c0.20			0.18	0.00
v/c Ratio	0.09	0.03	0.16		0.13			0.25			0.21	0.00
Uniform Delay, d1	50.8	50.5	51.1		51.0			2.1			2.0	1.7
Progression Factor	1.00	1.00	1.00		1.00			1.69			1.00	1.00
Incremental Delay, d2	0.4	0.1	0.9		0.4			0.3			0.2	0.0
Delay (s)	51.2	50.6	52.0		51.4			3.9			2.2	1.7
Level of Service	D	D	D		D			A			A	A
Approach Delay (s)		51.9			51.4			3.9			2.2	
Approach LOS		D			D			A			A	

Intersection Summary			
HCM Average Control Delay	11.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.24		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	47.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action
21: I-35 SB Ramps & Gardner Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	40	0	170	10	230	0	0	690	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0		5.0		5.0			5.0	5.0
Lane Util. Factor				1.00		1.00		1.00			1.00	1.00
Frt				1.00		0.85		1.00			1.00	0.85
Flt Protected				0.95		1.00		1.00			1.00	1.00
Satd. Flow (prot)				1671		1145		1826			1667	1495
Flt Permitted				0.95		1.00		0.97			1.00	1.00
Satd. Flow (perm)				1671		1145		1773			1667	1495
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	43	0	181	11	245	0	0	734	64
RTOR Reduction (vph)	0	0	0	0	0	166	0	0	0	0	0	11
Lane Group Flow (vph)	0	0	0	43	0	15	0	256	0	0	734	53
Heavy Vehicles (%)	0%	0%	0%	8%	0%	41%	0%	4%	0%	0%	14%	8%
Turn Type				Prot		custom	Perm					Perm
Protected Phases				3				2			6	
Permitted Phases						3	2					6
Actuated Green, G (s)				9.9		9.9		100.1			100.1	100.1
Effective Green, g (s)				9.9		9.9		100.1			100.1	100.1
Actuated g/C Ratio				0.08		0.08		0.83			0.83	0.83
Clearance Time (s)				5.0		5.0		5.0			5.0	5.0
Vehicle Extension (s)				3.0		3.0		3.0			3.0	3.0
Lane Grp Cap (vph)				138		94		1479			1391	1247
v/s Ratio Prot				c0.03							c0.44	
v/s Ratio Perm						0.01		0.14				0.04
v/c Ratio				0.31		0.16		0.17			0.53	0.04
Uniform Delay, d1				51.8		51.2		1.9			2.9	1.7
Progression Factor				1.00		1.00		0.61			1.03	0.51
Incremental Delay, d2				1.3		0.8		0.2			1.4	0.1
Delay (s)				53.1		52.0		1.4			4.5	0.9
Level of Service				D		D		A			A	A
Approach Delay (s)		0.0			52.2			1.4			4.2	
Approach LOS		A			D			A			A	

Intersection Summary			
HCM Average Control Delay	12.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	47.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

2015 Gardner IMF Operations - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

22: I-35 NB Ramps & Gardner Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	100	0	20	0	0	0	0	150	210	590	130	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.98						0.92			1.00	
Flt Protected		0.96						1.00			0.96	
Satd. Flow (prot)		1725						1705			1597	
Flt Permitted		0.96						1.00			0.53	
Satd. Flow (perm)		1725						1705			882	
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	110	0	22	0	0	0	0	165	231	648	143	0
RTOR Reduction (vph)	0	6	0	0	0	0	0	37	0	0	0	0
Lane Group Flow (vph)	0	126	0	0	0	0	0	359	0	0	791	0
Heavy Vehicles (%)	3%	0%	5%	0%	0%	0%	0%	5%	1%	17%	2%	0%
Turn Type	Perm									Perm		
Protected Phases		4						2			6	
Permitted Phases	4									6		
Actuated Green, G (s)		9.0						101.0			101.0	
Effective Green, g (s)		9.0						101.0			101.0	
Actuated g/C Ratio		0.08						0.84			0.84	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		129						1435			742	
v/s Ratio Prot								0.21				
v/s Ratio Perm		0.07									c0.90	
v/c Ratio		0.98						0.25			1.07	
Uniform Delay, d1		55.4						1.9			9.5	
Progression Factor		1.00						1.00			1.74	
Incremental Delay, d2		72.9						0.4			50.1	
Delay (s)		128.3						2.3			66.7	
Level of Service		F						A			E	
Approach Delay (s)		128.3			0.0			2.3			66.7	
Approach LOS		F			A			A			E	

Intersection Summary			
HCM Average Control Delay	53.5	HCM Level of Service	D
HCM Volume to Capacity ratio	1.06		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	79.5%	ICU Level of Service	D
Analysis Period (min)	15		

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BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

23: E 191st Street & Gardner Rd — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	10	350	0	5	150
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	11	376	0	5	161
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						220
pX, platoon unblocked						
vC, conflicting volume	548	376			376	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	548	376			376	
tC, single (s)	6.4	6.2			4.3	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.4	
p0 queue free %	100	98			100	
cM capacity (veh/h)	498	675			1090	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	11	376	167
Volume Left	0	0	5
Volume Right	11	0	0
cSH	675	1700	1090
Volume to Capacity	0.02	0.22	0.00
Queue Length 95th (ft)	1	0	0
Control Delay (s)	10.4	0.0	0.3
Lane LOS	B		A
Approach Delay (s)	10.4	0.0	0.3
Approach LOS	B		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	28.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

24: Sunflower Road & US 56 — AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	10	40	0	0	10	380	70	5	110	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	6	13	51	0	0	13	481	89	6	139	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	703	747	139	718	703	525	139			570		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	703	747	139	718	703	525	139			570		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	84	100	100	99			99		
cM capacity (veh/h)	351	339	914	323	359	556	1457			1013		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	25	51	582	146
Volume Left	6	51	13	6
Volume Right	13	0	89	0
cSH	501	323	1457	1013
Volume to Capacity	0.05	0.16	0.01	0.01
Queue Length 95th (ft)	4	14	1	0
Control Delay (s)	12.6	18.2	0.3	0.4
Lane LOS	B	C	A	A
Approach Delay (s)	12.6	18.2	0.3	0.4
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	41.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

25: US 56 & 4th Street — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	410	60	20	130	20	50
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	526	77	26	167	26	64
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			603		782	564
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			603		782	564
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		93	88
cM capacity (veh/h)			960		349	525

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	603	192	90
Volume Left	0	26	26
Volume Right	77	0	64
cSH	1700	960	459
Volume to Capacity	0.35	0.03	0.20
Queue Length 95th (ft)	0	2	18
Control Delay (s)	0.0	1.4	14.7
Lane LOS		A	B
Approach Delay (s)	0.0	1.4	14.7
Approach LOS			B

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	36.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

26: 199th Street & Four Corners Road — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	70	30	20	10	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	6	83	36	24	12	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	60				143	48
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	60				143	48
tC, single (s)	4.3				6.6	6.6
tC, 2 stage (s)						
tF (s)	2.4				3.7	3.7
p0 queue free %	100				99	99
cM capacity (veh/h)	1437				806	923

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	89	60	18
Volume Left	6	0	12
Volume Right	0	24	6
cSH	1437	1700	842
Volume to Capacity	0.00	0.04	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.5	0.0	9.4
Lane LOS	A		A
Approach Delay (s)	0.5	0.0	9.4
Approach LOS			A

Intersection Summary			
Average Delay	1.3		
Intersection Capacity Utilization	17.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

27: 199th Street & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	70	30	10	5	30	50	10	270	10	30	70	40
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	79	34	11	6	34	56	11	303	11	34	79	45

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	124	96	326	157
Volume Left (vph)	79	6	11	34
Volume Right (vph)	11	56	11	45
Hadj (s)	0.13	-0.30	0.03	-0.11
Departure Headway (s)	5.3	5.0	4.7	4.8
Degree Utilization, x	0.18	0.13	0.43	0.21
Capacity (veh/h)	609	644	731	700
Control Delay (s)	9.5	8.7	11.2	9.1
Approach Delay (s)	9.5	8.7	11.2	9.1
Approach LOS	A	A	B	A

Intersection Summary			
Delay	10.1		
HCM Level of Service	B		
Intersection Capacity Utilization	40.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

30: US-56 & I-35 NB Loop — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	410	1630	0	570	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	461	1831	0	640	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked						
vC, conflicting volume			2292		781	230
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			2292		781	230
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			224		336	778

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	230	230	1831	320	320
Volume Left	0	0	0	0	0
Volume Right	0	0	1831	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.14	0.14	1.08	0.19	0.19
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	104.3%	ICU Level of Service	G
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

80: 191st Street & Driveway A — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	5	5	65	95	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	5	71	103	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	76				57	41
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	76				57	41
tC, single (s)	5.1				7.4	7.2
tC, 2 stage (s)						
tF (s)	3.1				4.4	4.2
p0 queue free %	99				86	99
cM capacity (veh/h)	1077				749	809

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	11	76	103	5
Volume Left	5	0	103	0
Volume Right	0	71	0	5
cSH	1077	1700	749	809
Volume to Capacity	0.01	0.04	0.14	0.01
Queue Length 95th (ft)	0	0	12	1
Control Delay (s)	4.2	0.0	10.6	9.5
Lane LOS	A		B	A
Approach Delay (s)	4.2	0.0	10.5	
Approach LOS			B	

Intersection Summary			
Average Delay	6.1		
Intersection Capacity Utilization	16.7%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Gardner IMF Operations - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

82: Driveway C & Waverly Road — AM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	30	30	30	10	10	30
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	33	33	33	11	11	33
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	103	27	43			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	103	27	43			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	96	97	98			
cM capacity (veh/h)	881	1054	1578			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	33	33	43	43
Volume Left	33	0	33	0
Volume Right	0	33	0	33
cSH	881	1054	1578	1700
Volume to Capacity	0.04	0.03	0.02	0.03
Queue Length 95th (ft)	3	2	2	0
Control Delay (s)	9.2	8.5	5.5	0.0
Lane LOS	A	A	A	
Approach Delay (s)	8.9		5.5	0.0
Approach LOS	A			

Intersection Summary			
Average Delay	5.4		
Intersection Capacity Utilization	18.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

84: 191st Street & Driveway E — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	100	65	20	20	0
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	109	71	22	22	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	92				201	82
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	92				201	82
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				97	100
cM capacity (veh/h)	1502				785	978

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	114	92	22
Volume Left	5	0	22
Volume Right	0	22	0
cSH	1502	1700	785
Volume to Capacity	0.00	0.05	0.03
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.4	0.0	9.7
Lane LOS	A		A
Approach Delay (s)	0.4	0.0	9.7
Approach LOS			A

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	19.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

1: 175th Street & Waverly Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	100	5	5	320	90	10	20	5	40	20	20
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	24	120	6	6	386	108	12	24	6	48	24	24

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	151	500	42	96
Volume Left (vph)	24	6	12	48
Volume Right (vph)	6	108	6	24
Hadj (s)	0.09	-0.07	0.02	-0.02
Departure Headway (s)	5.0	4.4	5.6	5.5
Degree Utilization, x	0.21	0.61	0.07	0.15
Capacity (veh/h)	681	793	553	586
Control Delay (s)	9.2	14.2	9.0	9.4
Approach Delay (s)	9.2	14.2	9.0	9.4
Approach LOS	A	B	A	A

Intersection Summary			
Delay	12.4		
HCM Level of Service	B		
Intersection Capacity Utilization	37.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

2: US 56 & Gardner Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	310	60	250	720	250	70	170	160	160	170	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.98			0.97		1.00	0.93		1.00	0.97	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3294			3370		1787	1694		1736	1765	
Flt Permitted		0.78			0.75		0.54	1.00		0.34	1.00	
Satd. Flow (perm)		2573			2537		1009	1694		627	1765	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	34	356	69	287	828	287	80	195	184	184	195	57
RTOR Reduction (vph)	0	21	0	0	33	0	0	49	0	0	15	0
Lane Group Flow (vph)	0	438	0	0	1369	0	80	330	0	184	237	0
Heavy Vehicles (%)	3%	8%	2%	1%	4%	1%	1%	4%	4%	4%	4%	4%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		37.8			37.8		20.5	20.5		20.5	20.5	
Effective Green, g (s)		37.8			37.8		20.5	20.5		20.5	20.5	
Actuated g/C Ratio		0.54			0.54		0.29	0.29		0.29	0.29	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1389			1370		295	496		184	517	
v/s Ratio Prot								0.19			0.13	
v/s Ratio Perm		0.17			c0.54		0.08			c0.29		
v/c Ratio		0.32			1.00		0.27	0.67		1.00	0.46	
Uniform Delay, d1		8.9			16.1		19.0	21.7		24.7	20.2	
Progression Factor		1.00			0.32		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.6			22.7		0.5	3.4		66.3	0.6	
Delay (s)		9.5			27.9		19.5	25.1		91.1	20.9	
Level of Service		A			C		B	C		F	C	
Approach Delay (s)		9.5			27.9			24.1			50.5	
Approach LOS		A			C			C			D	

Intersection Summary			
HCM Average Control Delay	27.8	HCM Level of Service	C
HCM Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	11.7
Intersection Capacity Utilization	93.6%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

3: US 56 & Elm — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	650	20	40	1190	40	20	10	50	70	10	30
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			1.00			0.92			0.96	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3575			3669			1765			1856	
Flt Permitted		0.93			0.91			0.92			0.80	
Satd. Flow (perm)		3332			3350			1648			1524	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	11	699	22	43	1280	43	22	11	54	75	11	32
RTOR Reduction (vph)	0	2	0	0	2	0	0	47	0	0	25	0
Lane Group Flow (vph)	0	730	0	0	1364	0	0	40	0	0	93	0
Heavy Vehicles (%)	0%	6%	0%	3%	3%	0%	5%	0%	2%	1%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		51.9			51.9			9.1			9.1	
Effective Green, g (s)		51.9			51.9			9.1			9.1	
Actuated g/C Ratio		0.74			0.74			0.13			0.13	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2470			2484			214			198	
v/s Ratio Prot												
v/s Ratio Perm		0.22			c0.41			0.02			c0.06	
v/c Ratio		0.30			0.55			0.19			0.47	
Uniform Delay, d1		3.0			3.9			27.2			28.2	
Progression Factor		0.46			0.30			1.00			1.00	
Incremental Delay, d2		0.2			0.2			0.4			1.8	
Delay (s)		1.6			1.4			27.6			30.0	
Level of Service		A			A			C			C	
Approach Delay (s)		1.6			1.4			27.6			30.0	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	3.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	80.2%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

4: US 56 & Mulberry — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	760	10	30	1290	40	10	5	20	40	10	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			1.00			0.92			0.96	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3433			3491			1678			1776	
Flt Permitted		0.93			0.92			0.93			0.80	
Satd. Flow (perm)		3201			3229			1583			1467	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	11	817	11	32	1387	43	11	5	22	43	11	22
RTOR Reduction (vph)	0	1	0	0	3	0	0	20	0	0	20	0
Lane Group Flow (vph)	0	838	0	0	1459	0	0	18	0	0	56	0
Heavy Vehicles (%)	0%	5%	0%	0%	3%	0%	0%	0%	5%	0%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		54.5			54.5			6.5			6.5	
Effective Green, g (s)		54.5			54.5			6.5			6.5	
Actuated g/C Ratio		0.78			0.78			0.09			0.09	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2492			2514			147			136	
v/s Ratio Prot												
v/s Ratio Perm		0.26			c0.45			0.01			c0.04	
v/c Ratio		0.34			0.58			0.12			0.41	
Uniform Delay, d1		2.3			3.1			29.1			29.9	
Progression Factor		0.69			0.74			1.00			1.00	
Incremental Delay, d2		0.4			0.2			0.4			2.0	
Delay (s)		2.0			2.5			29.5			32.0	
Level of Service		A			A			C			C	
Approach Delay (s)		2.0			2.5			29.5			32.0	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	3.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	73.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

5: US 56 & Moonlight Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	130	460	250	190	1070	600	150	190	60	280	240	110
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1736	3585	1583	1770	3539	1583	1770	3539	1583	3433	3539	1553
Flt Permitted	0.16	1.00	1.00	0.42	1.00	1.00	0.59	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	287	3585	1583	790	3539	1583	1097	3539	1583	3433	3539	1553
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	143	505	275	209	1176	659	165	209	66	308	264	121
RTOR Reduction (vph)	0	0	175	0	0	290	0	0	58	0	0	105
Lane Group Flow (vph)	143	505	100	209	1176	369	165	209	8	308	264	16
Heavy Vehicles (%)	4%	6%	2%	2%	2%	2%	2%	2%	2%	2%	2%	4%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	Prot		Perm
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6	8		8			4
Actuated Green, G (s)	30.3	25.5	25.5	32.7	26.7	26.7	14.2	8.0	8.0	7.5	9.3	9.3
Effective Green, g (s)	30.3	25.5	25.5	32.7	26.7	26.7	14.2	8.0	8.0	7.5	9.3	9.3
Actuated g/C Ratio	0.43	0.36	0.36	0.47	0.38	0.38	0.20	0.11	0.11	0.11	0.13	0.13
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	224	1306	577	453	1350	604	282	404	181	368	470	206
v/s Ratio Prot	c0.04	0.14		0.04	c0.33		0.05	0.06		c0.09	c0.07	
v/s Ratio Perm	0.23		0.06	0.18		0.23	0.07		0.00			0.01
v/c Ratio	0.64	0.39	0.17	0.46	0.87	0.61	0.59	0.52	0.04	0.84	0.56	0.08
Uniform Delay, d1	14.3	16.5	15.1	11.3	20.1	17.5	24.5	29.2	27.6	30.7	28.4	26.6
Progression Factor	1.44	0.78	0.64	0.65	0.86	1.02	0.89	0.92	0.82	1.00	1.00	1.00
Incremental Delay, d2	4.2	0.8	0.6	0.2	6.6	3.7	2.0	0.5	0.0	14.5	0.9	0.1
Delay (s)	24.8	13.6	10.2	7.6	23.8	21.5	23.8	27.4	22.6	45.2	29.4	26.7
Level of Service	C	B	B	A	C	C	C	C	C	D	C	C
Approach Delay (s)		14.4			21.4			25.4			35.9	
Approach LOS		B			C			C			D	

Intersection Summary			
HCM Average Control Delay	22.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	11.0
Intersection Capacity Utilization	70.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

6: Old US 56 & US 56 — PM Peak Hour

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	120	20	690	110	10	1740
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	4.0	6.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1736	1538	3654	1553	1805	3725
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1736	1538	3654	1553	1805	3725
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	124	21	711	113	10	1794
RTOR Reduction (vph)	0	19	0	97	0	0
Lane Group Flow (vph)	124	2	711	16	10	1794
Heavy Vehicles (%)	4%	5%	4%	4%	0%	2%
Turn Type		Perm		custom	Prot	
Protected Phases	8		2	4	1	6
Permitted Phases		8				
Actuated Green, G (s)	7.7	7.7	46.9	7.7	1.4	51.3
Effective Green, g (s)	7.7	7.7	46.9	7.7	1.4	51.3
Actuated g/C Ratio	0.11	0.11	0.67	0.11	0.02	0.73
Clearance Time (s)	5.0	5.0	5.0	5.0	4.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	191	169	2448	171	36	2730
v/s Ratio Prot	c0.07		0.19	0.01	0.01	c0.48
v/s Ratio Perm		0.00				
v/c Ratio	0.65	0.01	0.29	0.09	0.28	0.66
Uniform Delay, d1	29.9	27.8	4.7	28.0	33.8	4.8
Progression Factor	1.00	1.00	0.42	2.59	1.00	1.00
Incremental Delay, d2	7.4	0.0	0.3	0.2	4.2	1.3
Delay (s)	37.3	27.8	2.2	72.6	38.0	6.1
Level of Service	D	C	A	E	D	A
Approach Delay (s)	35.9		11.9			6.2
Approach LOS	D		B			A

Intersection Summary			
HCM Average Control Delay	9.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	11.0
Intersection Capacity Utilization	61.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

7: US-56 & Cedar Niles — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	1310	180	520	1350	40	140	20	400	40	10	30
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00		1.00	0.88	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85	1.00	0.89	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1805	3689	1599	3502	3689	1615		1820	2842	1805	1685	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.72	1.00	0.47	1.00	
Satd. Flow (perm)	1805	3689	1599	3502	3689	1615		1368	2842	889	1685	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	45	1472	202	584	1517	45	157	22	449	45	11	34
RTOR Reduction (vph)	0	0	103	0	0	16	0	0	0	0	29	0
Lane Group Flow (vph)	45	1472	99	584	1517	29	0	179	449	45	16	0
Heavy Vehicles (%)	0%	3%	1%	0%	3%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Prot		Perm	Prot		Perm	Perm		pt+ov	Perm		
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases			2			6	8			4		
Actuated Green, G (s)	4.8	48.8	48.8	20.4	64.4	64.4		15.2	39.6	15.2	15.2	
Effective Green, g (s)	4.8	48.8	48.8	20.4	64.4	64.4		15.2	35.6	15.2	15.2	
Actuated g/C Ratio	0.05	0.49	0.49	0.20	0.64	0.64		0.15	0.36	0.15	0.15	
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2		5.2	5.2	
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0		1.0		1.0	1.0	
Lane Grp Cap (vph)	87	1800	780	714	2376	1040		208	1012	135	256	
v/s Ratio Prot	0.02	c0.40		c0.17	0.41				0.16		0.01	
v/s Ratio Perm			0.06			0.02		c0.13		0.05		
v/c Ratio	0.52	0.82	0.13	0.82	0.64	0.03		0.86	0.44	0.33	0.06	
Uniform Delay, d1	46.5	21.8	14.0	38.0	10.8	6.5		41.4	24.6	37.9	36.3	
Progression Factor	1.00	1.00	1.00	0.79	0.45	0.20		1.00	1.00	1.00	1.00	
Incremental Delay, d2	2.2	4.3	0.3	3.5	0.7	0.0		27.7	0.1	0.5	0.0	
Delay (s)	48.6	26.1	14.3	33.4	5.5	1.3		69.1	24.7	38.4	36.3	
Level of Service	D	C	B	C	A	A		E	C	D	D	
Approach Delay (s)		25.3			13.0			37.4			37.4	
Approach LOS		C			B			D			D	

Intersection Summary			
HCM Average Control Delay	21.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	15.6
Intersection Capacity Utilization	77.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

8: US-56 & I-35 SB Ramps — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1510	240	120	530	0	0	0	0	140	0	1380
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		0.98		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3462		1687	3725					1787		2787
Flt Permitted		1.00		0.95	1.00					0.95		1.00
Satd. Flow (perm)		3462		1687	3725					1787		2787
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1589	253	126	558	0	0	0	0	147	0	1453
RTOR Reduction (vph)	0	13	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	1829	0	126	558	0	0	0	0	147	0	1453
Heavy Vehicles (%)	0%	2%	3%	7%	2%	0%	0%	0%	0%	1%	0%	2%
Turn Type				Prot						Prot		custom
Protected Phases		2		1	6					7		5
Permitted Phases												4
Actuated Green, G (s)		61.1		12.6	23.3					11.3		50.4
Effective Green, g (s)		61.1		12.6	23.3					11.3		50.4
Actuated g/C Ratio		0.61		0.13	0.23					0.11		0.50
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2115		213	868					202		1405
v/s Ratio Prot		c0.53		0.07	c0.15					c0.08		c0.52
v/s Ratio Perm												
v/c Ratio		0.86		0.59	0.64					0.73		1.03
Uniform Delay, d1		16.0		41.3	34.6					42.9		24.8
Progression Factor		0.69		0.90	0.89					1.00		1.00
Incremental Delay, d2		3.7		3.9	3.3					12.3		33.3
Delay (s)		14.7		40.9	33.9					55.2		58.1
Level of Service		B		D	C					E		E
Approach Delay (s)		14.7			35.2			0.0			57.8	
Approach LOS		B			D			A			E	

Intersection Summary			
HCM Average Control Delay	34.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	75.5%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

9: US-56 & I-35 NB Ramps

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	530	0	0	560	20	90	0	40	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			1.00			0.96				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3762			1832			1586				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3762			1832			1586				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	602	0	0	636	23	102	0	45	0	0	0
RTOR Reduction (vph)	0	0	0	0	1	0	0	18	0	0	0	0
Lane Group Flow (vph)	0	602	0	0	658	0	0	129	0	0	0	0
Heavy Vehicles (%)	0%	1%	0%	0%	3%	10%	7%	0%	20%	0%	0%	0%
Turn Type							Perm					
Protected Phases		2			6			8				
Permitted Phases							8					
Actuated Green, G (s)		76.7			76.7			13.3				
Effective Green, g (s)		76.7			76.7			13.3				
Actuated g/C Ratio		0.77			0.77			0.13				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		2885			1405			211				
v/s Ratio Prot		0.16			c0.36							
v/s Ratio Perm								0.08				
v/c Ratio		0.21			0.47			0.61				
Uniform Delay, d1		3.2			4.2			40.9				
Progression Factor		0.66			1.00			1.00				
Incremental Delay, d2		0.1			1.1			5.1				
Delay (s)		2.2			5.4			46.0				
Level of Service		A			A			D				
Approach Delay (s)		2.2			5.4			46.0			0.0	
Approach LOS		A			A			D			A	

Intersection Summary			
HCM Average Control Delay	8.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	72.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

10: Sante Fe & Moonlight

PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	110	130	270	70	160	530
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.97		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3437		1770	3539
Flt Permitted	0.95	1.00	1.00		0.53	1.00
Satd. Flow (perm)	1770	1583	3437		995	3539
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	118	140	290	75	172	570
RTOR Reduction (vph)	0	120	22	0	0	0
Lane Group Flow (vph)	118	20	343	0	172	570
Heavy Vehicles (%)	2%	2%	2%	1%	2%	2%
Turn Type		Perm			Perm	
Protected Phases	6		8			4
Permitted Phases		6			4	
Actuated Green, G (s)	10.2	10.2	49.8		49.8	49.8
Effective Green, g (s)	10.2	10.2	49.8		49.8	49.8
Actuated g/C Ratio	0.15	0.15	0.71		0.71	0.71
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	258	231	2445		708	2518
v/s Ratio Prot	c0.07		0.10			0.16
v/s Ratio Perm		0.01			c0.17	
v/c Ratio	0.46	0.09	0.14		0.24	0.23
Uniform Delay, d1	27.4	25.9	3.2		3.5	3.5
Progression Factor	1.00	1.00	1.00		0.98	0.97
Incremental Delay, d2	1.3	0.2	0.1		0.7	0.2
Delay (s)	28.7	26.0	3.4		4.2	3.6
Level of Service	C	C	A		A	A
Approach Delay (s)	27.2		3.4			3.7
Approach LOS	C		A			A

Intersection Summary			
HCM Average Control Delay	8.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.28		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	37.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

11: Waverly Road & US 56

PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	20	10	10	10	20	20	140	0	10	300	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	25	13	13	13	25	25	177	0	13	380	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	668	639	177	661	636	383	386			177		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	668	639	177	661	636	383	386			177		
tC, single (s)	7.1	6.6	6.6	7.2	6.6	6.2	4.1			4.6		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.7	3.6	4.1	3.3	2.2			2.7		
p0 queue free %	100	93	98	96	97	96	98			99		
cM capacity (veh/h)	342	377	777	332	373	658	1183			1155		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	38	51	203	399
Volume Left	0	13	25	13
Volume Right	13	25	0	6
cSH	455	458	1183	1155
Volume to Capacity	0.08	0.11	0.02	0.01
Queue Length 95th (ft)	7	9	2	1
Control Delay (s)	13.6	13.8	1.2	0.4
Lane LOS	B	B	A	A
Approach Delay (s)	13.6	13.8	1.2	0.4
Approach LOS	B	B		

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	33.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

12: 183rd Street & Four Corners Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	10	5	0	10	10	5	5	0	5	5	5
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	11	5	0	11	11	5	5	0	5	5	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	22	22	11	16
Volume Left (vph)	5	0	5	5
Volume Right (vph)	5	11	0	5
Hadj (s)	-0.10	-0.30	0.10	-0.13
Departure Headway (s)	3.9	3.7	4.1	3.9
Degree Utilization, x	0.02	0.02	0.01	0.02
Capacity (veh/h)	915	965	855	916
Control Delay (s)	7.0	6.8	7.2	6.9
Approach Delay (s)	7.0	6.8	7.2	6.9
Approach LOS	A	A	A	A

Intersection Summary			
Delay	6.9		
HCM Level of Service	A		
Intersection Capacity Utilization	15.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

13: 183rd Street & US 56 — PM Peak Hour

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	5	0	0	160	310	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	0	0	203	392	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	595	392	392			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	595	392	392			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	99	100	100			
cM capacity (veh/h)	470	661	1177			

Direction, Lane #	SE 1	NE 1	SW 1
Volume Total	6	203	392
Volume Left	6	0	0
Volume Right	0	0	0
cSH	470	1177	1700
Volume to Capacity	0.01	0.00	0.23
Queue Length 95th (ft)	1	0	0
Control Delay (s)	12.8	0.0	0.0
Lane LOS	B		
Approach Delay (s)	12.8	0.0	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	26.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

14: 183rd Street & Waverly Road — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	5	20	10	5	5	10
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	22	11	5	5	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	35	14			16	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	35	14			16	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	98			100	
cM capacity (veh/h)	979	1072			1614	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	27	16	16
Volume Left	5	0	5
Volume Right	22	5	0
cSH	1052	1700	1614
Volume to Capacity	0.03	0.01	0.00
Queue Length 95th (ft)	2	0	0
Control Delay (s)	8.5	0.0	2.4
Lane LOS	A		A
Approach Delay (s)	8.5	0.0	2.4
Approach LOS	A		

Intersection Summary			
Average Delay	4.5		
Intersection Capacity Utilization	15.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

15: 183rd Street & Gardner Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	30	30	60	40	50	80	310	120	70	280	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	2.5	2.5		2.5	2.5		2.5	2.5		2.5	2.5	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.92		1.00	0.92		1.00	0.96		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1752	1732		1770	1700		1787	3320		1787	3402	
Flt Permitted	0.64	1.00		0.71	1.00		0.50	1.00		0.47	1.00	
Satd. Flow (perm)	1180	1732		1328	1700		950	3320		884	3402	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	34	34	34	67	45	56	90	348	135	79	315	56
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	34	68	0	67	101	0	90	483	0	79	371	0
Heavy Vehicles (%)	3%	0%	3%	2%	3%	2%	1%	5%	2%	1%	4%	2%
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	9.1	6.9		13.7	9.2		39.7	35.3		37.5	34.2	
Effective Green, g (s)	9.1	6.9		13.7	9.2		39.7	35.3		37.5	34.2	
Actuated g/C Ratio	0.15	0.12		0.23	0.15		0.66	0.59		0.62	0.57	
Clearance Time (s)	2.5	2.5		2.5	2.5		2.5	2.5		2.5	2.5	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	200	199		336	261		690	1953		602	1939	
v/s Ratio Prot	0.01	0.04		c0.01	c0.06		c0.01	c0.15		c0.01	0.11	
v/s Ratio Perm	0.02			0.03			0.08			0.07		
v/c Ratio	0.17	0.34		0.20	0.39		0.13	0.25		0.13	0.19	
Uniform Delay, d1	22.6	24.5		18.8	22.9		3.6	5.9		4.4	6.2	
Progression Factor	1.00	1.00		1.00	1.00		0.87	0.72		1.00	1.00	
Incremental Delay, d2	0.4	1.0		0.3	1.0		0.1	0.3		0.1	0.0	
Delay (s)	23.1	25.6		19.1	23.8		3.2	4.6		4.5	6.3	
Level of Service	C	C		B	C		A	A		A	A	
Approach Delay (s)		24.7			21.9			4.4			6.0	
Approach LOS		C			C			A			A	

Intersection Summary			
HCM Average Control Delay	8.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.26		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	36.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

16: Four Corners Road & US 56 — PM Peak Hour

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	0	5	5	180	320	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	0	7	7	237	421	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	671	421	421			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	671	421	421			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	99	99			
cM capacity (veh/h)	422	637	1149			

Direction, Lane #	SB 1	NE 1	SW 1
Volume Total	7	243	421
Volume Left	0	7	0
Volume Right	7	0	0
cSH	637	1149	1700
Volume to Capacity	0.01	0.01	0.25
Queue Length 95th (ft)	1	0	0
Control Delay (s)	10.7	0.3	0.0
Lane LOS	B	A	
Approach Delay (s)	10.7	0.3	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.2		
Intersection Capacity Utilization	26.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

17: 191st Street & US 56 — PM Peak Hour

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	5	5	5	170	320	10
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	6	6	6	221	416	13
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	656	422	429			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	656	422	429			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	99	99			
cM capacity (veh/h)	431	636	1142			

Direction, Lane #	SE 1	NE 1	SW 1
Volume Total	13	227	429
Volume Left	6	6	0
Volume Right	6	0	13
cSH	514	1142	1700
Volume to Capacity	0.03	0.01	0.25
Queue Length 95th (ft)	2	0	0
Control Delay (s)	12.2	0.3	0.0
Lane LOS	B	A	
Approach Delay (s)	12.2	0.3	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	27.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

19: 191st Street & Waverly Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	90	0	5	120	10	5	5	5	10	5	10
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	98	0	5	130	11	5	5	5	11	5	11
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	141			98			280	272	98	274	266	136
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	141			98			280	272	98	274	266	136
tC, single (s)	4.6			4.1			7.1	6.5	6.2	7.1	6.5	6.8
tC, 2 stage (s)												
tF (s)	2.7			2.2			3.5	4.0	3.3	3.5	4.0	3.8
p0 queue free %	99			100			99	99	99	98	99	99
cM capacity (veh/h)	1194			1508			656	630	964	667	635	779

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	109	147	16	27
Volume Left	11	5	5	11
Volume Right	0	11	5	11
cSH	1194	1508	723	700
Volume to Capacity	0.01	0.00	0.02	0.04
Queue Length 95th (ft)	1	0	2	3
Control Delay (s)	0.9	0.3	10.1	10.3
Lane LOS	A	A	B	B
Approach Delay (s)	0.9	0.3	10.1	10.3
Approach LOS			B	B

Intersection Summary			
Average Delay	2.0		
Intersection Capacity Utilization	18.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

20: W 188th Street & Gardner Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	10	120	20	10	20	130	580	20	20	440	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00			0.95			0.95	1.00
Frt	1.00	1.00	0.85		0.95			1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00		0.98			0.99			1.00	1.00
Satd. Flow (prot)	1805	1900	934		1762			3025			3502	1468
Flt Permitted	0.72	1.00	1.00		0.86			0.78			0.91	1.00
Satd. Flow (perm)	1370	1900	934		1554			2369			3205	1468
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	11	11	126	22	11	22	137	611	22	22	463	11
RTOR Reduction (vph)	0	0	111	0	19	0	0	2	0	0	0	3
Lane Group Flow (vph)	11	11	15	0	36	0	0	768	0	0	485	8
Heavy Vehicles (%)	0%	0%	73%	0%	0%	0%	82%	4%	0%	0%	3%	10%
Turn Type	Perm		Perm	Perm			Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	7.2	7.2	7.2		7.2			42.8			42.8	42.8
Effective Green, g (s)	7.2	7.2	7.2		7.2			42.8			42.8	42.8
Actuated g/C Ratio	0.12	0.12	0.12		0.12			0.71			0.71	0.71
Clearance Time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	164	228	112		186			1690			2286	1047
v/s Ratio Prot		0.01										
v/s Ratio Perm	0.01		0.02		c0.02			c0.32			0.15	0.01
v/c Ratio	0.07	0.05	0.14		0.19			0.45			0.21	0.01
Uniform Delay, d1	23.4	23.4	23.6		23.8			3.6			2.9	2.5
Progression Factor	1.00	1.00	1.00		1.00			0.81			0.36	0.03
Incremental Delay, d2	0.2	0.1	0.6		0.5			0.7			0.2	0.0
Delay (s)	23.6	23.5	24.2		24.3			3.7			1.3	0.1
Level of Service	C	C	C		C			A			A	A
Approach Delay (s)		24.1			24.3			3.7			1.2	
Approach LOS		C			C			A			A	

Intersection Summary			
HCM Average Control Delay	5.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	55.2%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

21: I-35 SB Ramps & Gardner Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	170	0	550	10	170	0	0	480	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0		5.0		5.0			5.0	5.0
Lane Util. Factor				1.00		1.00		1.00			1.00	1.00
Frt				1.00		0.85		1.00			1.00	0.85
Flt Protected				0.95		1.00		1.00			1.00	1.00
Satd. Flow (prot)				1736		1313		1783			1583	1495
Flt Permitted				0.95		1.00		0.97			1.00	1.00
Satd. Flow (perm)				1736		1313		1739			1583	1495
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	181	0	585	11	181	0	0	511	106
RTOR Reduction (vph)	0	0	0	0	0	456	0	0	0	0	0	41
Lane Group Flow (vph)	0	0	0	181	0	129	0	192	0	0	511	65
Heavy Vehicles (%)	0%	0%	0%	4%	0%	23%	10%	6%	0%	0%	20%	8%
Turn Type				Prot		custom	Perm					Perm
Protected Phases				3				2			6	
Permitted Phases						3	2					6
Actuated Green, G (s)				13.2		13.2		36.8			36.8	36.8
Effective Green, g (s)				13.2		13.2		36.8			36.8	36.8
Actuated g/C Ratio				0.22		0.22		0.61			0.61	0.61
Clearance Time (s)				5.0		5.0		5.0			5.0	5.0
Vehicle Extension (s)				3.0		3.0		3.0			3.0	3.0
Lane Grp Cap (vph)				382		289		1067			971	917
v/s Ratio Prot				c0.10							c0.32	
v/s Ratio Perm						0.10		0.11				0.04
v/c Ratio				0.47		0.45		0.18			0.53	0.07
Uniform Delay, d1				20.4		20.2		5.0			6.6	4.7
Progression Factor				1.00		1.00		1.03			0.78	0.52
Incremental Delay, d2				0.9		1.1		0.4			2.0	0.1
Delay (s)				21.3		21.3		5.5			7.2	2.6
Level of Service				C		C		A			A	A
Approach Delay (s)		0.0			21.3			5.5			6.4	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM Average Control Delay	13.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	51.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

22: I-35 NB Ramps & Gardner Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	0	20	0	0	0	0	130	50	330	320	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.96						0.96			1.00	
Flt Protected		0.97						1.00			0.98	
Satd. Flow (prot)		1583						1771			1608	
Flt Permitted		0.97						1.00			0.74	
Satd. Flow (perm)		1583						1771			1219	
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	55	0	22	0	0	0	0	143	55	363	352	0
RTOR Reduction (vph)	0	20	0	0	0	0	0	13	0	0	0	0
Lane Group Flow (vph)	0	57	0	0	0	0	0	185	0	0	715	0
Heavy Vehicles (%)	14%	0%	5%	0%	0%	0%	0%	3%	4%	29%	1%	0%
Turn Type	Perm									Perm		
Protected Phases		4						2			6	
Permitted Phases	4									6		
Actuated Green, G (s)		4.2						45.8			45.8	
Effective Green, g (s)		4.2						45.8			45.8	
Actuated g/C Ratio		0.07						0.76			0.76	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		111						1352			931	
v/s Ratio Prot								0.10				
v/s Ratio Perm		0.04									c0.59	
v/c Ratio		0.51						0.14			0.77	
Uniform Delay, d1		26.9						1.9			4.1	
Progression Factor		1.00						1.00			0.85	
Incremental Delay, d2		3.6						0.2			5.5	
Delay (s)		30.6						2.1			9.0	
Level of Service		C						A			A	
Approach Delay (s)		30.6			0.0			2.1			9.0	
Approach LOS		C			A			A			A	

Intersection Summary			
HCM Average Control Delay	9.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	63.3%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

23: E 191st Street & Gardner Rd — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	5	180	5	10	330
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	5	194	5	11	355
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						220
pX, platoon unblocked						
vC, conflicting volume	573	196			199	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	573	196			199	
tC, single (s)	6.4	6.4			4.2	
tC, 2 stage (s)						
tF (s)	3.5	3.5			2.3	
p0 queue free %	100	99			99	
cM capacity (veh/h)	481	801			1327	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	5	199	366
Volume Left	0	0	11
Volume Right	5	5	0
cSH	801	1700	1327
Volume to Capacity	0.01	0.12	0.01
Queue Length 95th (ft)	1	0	1
Control Delay (s)	9.5	0.0	0.3
Lane LOS	A		A
Approach Delay (s)	9.5	0.0	0.3
Approach LOS	A		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	35.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

24: Sunflower Road & US 56 — PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	5	10	40	5	0	10	180	40	0	380	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	6	13	51	6	0	13	228	51	0	481	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	766	788	484	778	766	253	487			278		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	766	788	484	778	766	253	487			278		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	100	98	98	83	98	100	99			100		
cM capacity (veh/h)	315	322	587	293	331	790	1086			1296		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	19	57	291	487
Volume Left	0	51	13	0
Volume Right	13	0	51	6
cSH	460	296	1086	1296
Volume to Capacity	0.04	0.19	0.01	0.00
Queue Length 95th (ft)	3	17	1	0
Control Delay (s)	13.2	20.0	0.5	0.0
Lane LOS	B	C	A	
Approach Delay (s)	13.2	20.0	0.5	0.0
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	36.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

25: US 56 & 4th Street — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	190	20	60	360	70	40
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	244	26	77	462	90	51
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			269		872	256
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			269		872	256
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			94		70	93
cM capacity (veh/h)			1306		303	787

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	269	538	141
Volume Left	0	77	90
Volume Right	26	0	51
cSH	1700	1306	391
Volume to Capacity	0.16	0.06	0.36
Queue Length 95th (ft)	0	5	40
Control Delay (s)	0.0	1.7	19.3
Lane LOS		A	C
Approach Delay (s)	0.0	1.7	19.3
Approach LOS			C

Intersection Summary			
Average Delay	3.8		
Intersection Capacity Utilization	49.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

26: 199th Street & Four Corners Road

PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	40	50	5	10	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	6	48	60	6	12	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	65				122	62
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	65				122	62
tC, single (s)	4.5				6.6	6.6
tC, 2 stage (s)						
tF (s)	2.6				3.7	3.7
p0 queue free %	100				99	99
cM capacity (veh/h)	1326				828	905

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	54	65	18
Volume Left	6	0	12
Volume Right	0	6	6
cSH	1326	1700	852
Volume to Capacity	0.00	0.04	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.9	0.0	9.3
Lane LOS	A		A
Approach Delay (s)	0.9	0.0	9.3
Approach LOS			A

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	16.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

27: 199th Street & Gardner Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	20	20	10	40	40	10	100	10	40	190	50
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	22	22	22	11	45	45	11	112	11	45	213	56

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	67	101	135	315
Volume Left (vph)	22	11	11	45
Volume Right (vph)	22	45	11	56
Hadj (s)	-0.08	-0.16	0.02	-0.04
Departure Headway (s)	5.0	4.9	4.7	4.5
Degree Utilization, x	0.09	0.14	0.18	0.39
Capacity (veh/h)	644	665	721	774
Control Delay (s)	8.5	8.7	8.7	10.3
Approach Delay (s)	8.5	8.7	8.7	10.3
Approach LOS	A	A	A	B

Intersection Summary			
Delay	9.5		
HCM Level of Service	A		
Intersection Capacity Utilization	36.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

30: US-56 & I-35 NB Loop

PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	530	1120	0	650	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	596	1258	0	730	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked						
vC, conflicting volume			1854		961	298
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1854		961	298
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			331		258	704

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	298	298	1258	365	365
Volume Left	0	0	0	0	0
Volume Right	0	0	1258	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.18	0.18	0.74	0.21	0.21
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	72.7%	ICU Level of Service	C
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action

80: 191st Street & Driveway A

PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	5	5	115	90	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	5	125	98	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	130				84	68
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	130				84	68
tC, single (s)	5.1				7.4	7.2
tC, 2 stage (s)						
tF (s)	3.1				4.4	4.2
p0 queue free %	99				86	99
cM capacity (veh/h)	1021				720	778

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	11	130	98	5
Volume Left	5	0	98	0
Volume Right	0	125	0	5
cSH	1021	1700	720	778
Volume to Capacity	0.01	0.08	0.14	0.01
Queue Length 95th (ft)	0	0	12	1
Control Delay (s)	4.3	0.0	10.8	9.7
Lane LOS	A		B	A
Approach Delay (s)	4.3	0.0	10.7	
Approach LOS			B	

Intersection Summary			
Average Delay	4.7		
Intersection Capacity Utilization	19.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action
82: Driveway C & Waverly Road — PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	5	5	5	10	10	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	5	11	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	35	14	16			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	35	14	16			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	99	99	100			
cM capacity (veh/h)	979	1072	1614			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	5	5	16	16
Volume Left	5	0	5	0
Volume Right	0	5	0	5
cSH	979	1072	1614	1700
Volume to Capacity	0.01	0.01	0.00	0.01
Queue Length 95th (ft)	0	0	0	0
Control Delay (s)	8.7	8.4	2.4	0.0
Lane LOS	A	A	A	
Approach Delay (s)	8.5		2.4	0.0
Approach LOS	A			

Intersection Summary			
Average Delay	3.0		
Intersection Capacity Utilization	15.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action
84: 191st Street & Driveway E — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	90	115	5	5	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	98	125	5	5	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	130				236	128
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	130				236	128
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	99
cM capacity (veh/h)	1467				753	928

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	103	130	11
Volume Left	5	0	5
Volume Right	0	5	5
cSH	1467	1700	832
Volume to Capacity	0.00	0.08	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.4	0.0	9.4
Lane LOS	A		A
Approach Delay (s)	0.4	0.0	9.4
Approach LOS			A

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	18.8%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner No Action - AM Peak Hour - Synchro Intersection LOS

1: 175th Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Volume (vph)	70	20	570	10	10	10	310	230	10	20	150	50
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.86		1.00	0.92		1.00	0.99		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1736	1678		1805	1850		1770	3486		1805	3324	
Flt Permitted	0.74	1.00		0.29	1.00		0.62	1.00		0.60	1.00	
Satd. Flow (perm)	1357	1678		551	1850		1154	3486		1131	3324	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	21	600	11	11	11	326	242	11	21	158	53
RTOR Reduction (vph)	0	508	0	0	9	0	0	2	0	0	20	0
Lane Group Flow (vph)	74	113	0	11	13	0	326	251	0	21	191	0
Heavy Vehicles (%)	4%	0%	2%	0%	0%	0%	2%	3%	0%	0%	4%	6%
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	13.8	13.8		13.8	13.8		66.2	59.2		54.5	52.5	
Effective Green, g (s)	13.8	13.8		13.8	13.8		66.2	59.2		54.5	52.5	
Actuated g/C Ratio	0.15	0.15		0.15	0.15		0.74	0.66		0.61	0.58	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	208	257		84	284		908	2293		700	1939	
v/s Ratio Prot		c0.07			0.01		c0.03	0.07		0.00	0.06	
v/s Ratio Perm	0.05			0.02			c0.23			0.02		
v/c Ratio	0.36	0.44		0.13	0.04		0.36	0.11		0.03	0.10	
Uniform Delay, d1	34.1	34.6		32.9	32.5		4.4	5.7		7.1	8.3	
Progression Factor	1.00	1.00		1.00	1.00		0.47	0.39		1.00	1.00	
Incremental Delay, d2	1.0	1.2		0.7	0.1		0.2	0.1		0.0	0.1	
Delay (s)	35.2	35.8		33.6	32.5		2.3	2.3		7.2	8.4	
Level of Service	D	D		C	C		A	A		A	A	
Approach Delay (s)		35.7			32.9			2.3			8.3	
Approach LOS		D			C			A			A	

Intersection Summary			
HCM Average Control Delay	19.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.37		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	69.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

2: US 56 & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↑	↱	↰	↑↑	↱	↰↰	↑↱	
Volume (vph)	130	780	60	180	430	220	80	1040	310	370	850	120
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3619	1583	1687	3551	1538	1752	3689	1553	3367	3444	
Flt Permitted	0.43	1.00	1.00	0.16	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	793	3619	1583	283	3551	1538	1752	3689	1553	3367	3444	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	821	63	189	453	232	84	1095	326	389	895	126
RTOR Reduction (vph)	0	0	42	0	0	167	0	0	120	0	12	0
Lane Group Flow (vph)	137	821	21	189	453	65	84	1095	206	389	1009	0
Heavy Vehicles (%)	2%	5%	2%	7%	7%	5%	3%	3%	4%	4%	3%	2%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			
Actuated Green, G (s)	30.8	24.3	24.3	32.4	25.1	25.1	6.2	29.7	29.7	12.0	35.5	
Effective Green, g (s)	30.8	24.3	24.3	32.4	25.1	25.1	6.2	29.7	29.7	12.0	35.5	
Actuated g/C Ratio	0.34	0.27	0.27	0.36	0.28	0.28	0.07	0.33	0.33	0.13	0.39	
Clearance Time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	342	977	427	216	990	429	121	1217	512	449	1358	
v/s Ratio Prot	0.03	0.23		c0.07	0.13		0.05	c0.30		c0.12	0.29	
v/s Ratio Perm	0.11		0.01	c0.24		0.04			0.13			
v/c Ratio	0.40	0.84	0.05	0.88	0.46	0.15	0.69	0.90	0.40	0.87	0.74	
Uniform Delay, d1	21.2	31.0	24.3	22.6	26.8	24.4	41.0	28.7	23.3	38.2	23.3	
Progression Factor	0.47	0.57	0.32	1.32	1.06	2.57	0.73	0.59	0.25	1.00	1.00	
Incremental Delay, d2	0.7	8.1	0.2	28.9	1.4	0.7	10.6	6.2	0.3	15.9	2.2	
Delay (s)	10.7	25.8	7.9	58.7	29.9	63.6	40.5	23.2	6.1	54.2	25.6	
Level of Service	B	C	A	E	C	E	D	C	A	D	C	
Approach Delay (s)		22.6			45.1			20.5			33.5	
Approach LOS		C			D			C			C	

Intersection Summary			
HCM Average Control Delay	29.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	13.3
Intersection Capacity Utilization	84.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

3: US 56 & Elm

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↱			↰↱		↰	↱		↰	↱	
Volume (vph)	20	1450	10	10	790	90	10	10	30	110	10	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			0.98		1.00	0.89		1.00	0.88	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3468			3339		1805	1651		1770	1610	
Flt Permitted		0.93			0.93		0.72	1.00		0.73	1.00	
Satd. Flow (perm)		3244			3106		1373	1651		1358	1610	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	1526	11	11	832	95	11	11	32	116	11	42
RTOR Reduction (vph)	0	0	0	0	6	0	0	28	0	0	37	0
Lane Group Flow (vph)	0	1558	0	0	932	0	11	15	0	116	16	0
Heavy Vehicles (%)	0%	4%	0%	0%	7%	2%	0%	0%	3%	2%	0%	5%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		69.5			69.5		11.5	11.5		11.5	11.5	
Effective Green, g (s)		69.5			69.5		11.5	11.5		11.5	11.5	
Actuated g/C Ratio		0.77			0.77		0.13	0.13		0.13	0.13	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2505			2399		175	211		174	206	
v/s Ratio Prot								0.01			0.01	
v/s Ratio Perm		c0.48			0.30		0.01			c0.09		
v/c Ratio		0.62			0.39		0.06	0.07		0.67	0.08	
Uniform Delay, d1		4.5			3.3		34.5	34.6		37.4	34.6	
Progression Factor		0.63			0.98		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.8			0.5		0.2	0.1		9.3	0.2	
Delay (s)		3.6			3.7		34.7	34.7		46.7	34.8	
Level of Service		A			A		C	C		D	C	
Approach Delay (s)		3.6			3.7			34.7			43.0	
Approach LOS		A			A			C			D	

Intersection Summary			
HCM Average Control Delay	6.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	74.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

4: US 56 & Mulberry

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↱			↰↱		↰	↱		↰	↱	
Volume (vph)	40	1610	10	10	840	60	5	5	20	100	5	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			0.99		1.00	0.88		1.00	0.87	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3464			3339		1805	1548		1770	1612	
Flt Permitted		0.90			0.92		0.73	1.00		0.74	1.00	
Satd. Flow (perm)		3132			3090		1393	1548		1379	1612	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	42	1695	11	11	884	63	5	5	21	105	5	32
RTOR Reduction (vph)	0	0	0	0	4	0	0	19	0	0	28	0
Lane Group Flow (vph)	0	1748	0	0	954	0	5	7	0	105	9	0
Heavy Vehicles (%)	5%	4%	0%	0%	7%	8%	0%	20%	5%	2%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		70.3			70.3		10.7	10.7		10.7	10.7	
Effective Green, g (s)		70.3			70.3		10.7	10.7		10.7	10.7	
Actuated g/C Ratio		0.78			0.78		0.12	0.12		0.12	0.12	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2446			2414		166	184		164	192	
v/s Ratio Prot								0.00			0.01	
v/s Ratio Perm		c0.56			0.31		0.00			c0.08		
v/c Ratio		0.71			0.40		0.03	0.04		0.64	0.05	
Uniform Delay, d1		4.9			3.1		35.1	35.1		37.8	35.1	
Progression Factor		0.36			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.5			0.1		0.1	0.1		8.3	0.1	
Delay (s)		3.3			3.2		35.1	35.2		46.1	35.2	
Level of Service		A			A		D	D		D	D	
Approach Delay (s)		3.3			3.2			35.2			43.2	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	5.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	93.2%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action
5: US 56 & Moonlight Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	170	1370	200	150	670	590	140	630	270	1210	520	110
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3654	1568	1770	3519	1583	1770	3725	1553	3433	3539	1553
Flt Permitted	0.21	1.00	1.00	0.10	1.00	1.00	0.45	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	394	3654	1568	195	3519	1583	834	3725	1553	3433	3539	1553
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	179	1442	211	158	705	621	147	663	284	1274	547	116
RTOR Reduction (vph)	0	0	58	0	0	350	0	0	62	0	0	74
Lane Group Flow (vph)	179	1442	153	158	705	271	147	663	222	1274	547	42
Heavy Vehicles (%)	2%	4%	3%	2%	8%	2%	2%	2%	4%	2%	2%	4%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		custom	Prot		Perm
Protected Phases	5	2		1	6		3	8	8	7	4	
Permitted Phases	2		2	6		6	8		8			4
Actuated Green, G (s)	51.3	42.5	42.5	42.7	38.2	38.2	24.0	17.5	17.5	32.5	43.5	43.5
Effective Green, g (s)	51.3	42.5	42.5	42.7	38.2	38.2	24.0	17.5	17.5	32.5	43.5	43.5
Actuated g/C Ratio	0.43	0.35	0.35	0.36	0.32	0.32	0.20	0.15	0.15	0.27	0.36	0.36
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	269	1294	555	128	1120	504	218	543	226	930	1283	563
v/s Ratio Prot	0.05	c0.39		c0.05	0.20		0.04	c0.18	0.14	c0.37	0.15	
v/s Ratio Perm	0.24		0.10	c0.39		0.17	0.10					0.03
v/c Ratio	0.67	1.11	0.28	1.23	0.63	0.54	0.67	1.22	0.98	1.37	0.43	0.07
Uniform Delay, d1	23.9	38.7	27.7	38.1	34.9	33.6	42.2	51.2	51.1	43.8	28.8	25.1
Progression Factor	1.00	1.00	1.00	0.89	0.87	1.27	0.85	0.82	0.72	1.00	1.00	1.00
Incremental Delay, d2	4.7	62.6	1.2	151.5	2.4	3.6	5.3	112.9	49.1	173.3	0.1	0.0
Delay (s)	28.6	101.4	29.0	185.5	32.6	46.2	41.3	155.1	85.9	217.1	28.9	25.1
Level of Service	C	F	C	F	C	D	D	F	F	F	C	C
Approach Delay (s)		85.9			54.6			121.8			152.5	
Approach LOS		F			D			F			F	

Intersection Summary			
HCM Average Control Delay	105.1	HCM Level of Service	F
HCM Volume to Capacity ratio	1.32		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	28.5
Intersection Capacity Utilization	114.5%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action
6: Old US 56 & US 56 — AM Peak Hour

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	150	10	1880	970	10	1290
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1615	3654	1583	1805	3619
Flt Permitted	0.95	1.00	1.00	1.00	0.05	1.00
Satd. Flow (perm)	1770	1615	3654	1583	98	3619
Peak-hour factor, PHF	0.97	0.97	0.95	0.95	0.95	0.95
Adj. Flow (vph)	155	10	1979	1021	11	1358
RTOR Reduction (vph)	0	9	0	120	0	0
Lane Group Flow (vph)	155	1	1979	901	11	1358
Heavy Vehicles (%)	2%	0%	4%	2%	0%	5%
Turn Type		Perm		pm+ov	pm+pt	
Protected Phases	8		2	8	1	6
Permitted Phases		8	2	2	6	6
Actuated Green, G (s)	17.9	17.9	85.9	103.8	92.1	92.1
Effective Green, g (s)	17.9	17.9	85.9	103.8	92.1	92.1
Actuated g/C Ratio	0.15	0.15	0.72	0.86	0.77	0.77
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	264	241	2616	1435	92	2778
v/s Ratio Prot	0.09		c0.54	c0.09	0.00	c0.38
v/s Ratio Perm		0.00		0.48	0.09	
v/c Ratio	0.59	0.01	0.76	0.63	0.12	0.49
Uniform Delay, d1	47.6	43.5	10.6	2.4	12.9	5.2
Progression Factor	1.00	1.00	0.88	11.67	1.11	0.99
Incremental Delay, d2	3.3	0.0	0.2	0.1	0.3	0.1
Delay (s)	50.9	43.5	9.5	28.0	14.7	5.2
Level of Service	D	D	A	C	B	A
Approach Delay (s)	50.5		15.8			5.3
Approach LOS	D		B			A

Intersection Summary			
HCM Average Control Delay	13.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	71.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action
7: US-56 & Cedar Niles — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	2070	160	670	2120	100	130	30	760	60	20	70
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2	5.2	5.2	5.2	5.2
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00	1.00	1.00	0.88	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1787	3725	1583	3433	3689	1583	1770	1942	2787	1752	2000	1553
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.74	1.00	1.00	0.74	1.00	1.00
Satd. Flow (perm)	1787	3725	1583	3433	3689	1583	1385	1942	2787	1358	2000	1553
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	2179	168	705	2232	105	137	32	800	63	21	74
RTOR Reduction (vph)	0	0	66	0	0	28	0	0	0	0	0	65
Lane Group Flow (vph)	74	2179	102	705	2232	77	137	32	800	63	21	9
Heavy Vehicles (%)	1%	2%	2%	2%	3%	2%	2%	3%	2%	3%	0%	4%
Turn Type	Prot		Perm	Prot		Perm	Perm		pt+ov	Perm		Perm
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases			2			6	8			4		4
Actuated Green, G (s)	5.6	68.8	68.8	23.0	86.2	86.2	12.6	12.6	40.8	12.6	12.6	12.6
Effective Green, g (s)	5.6	68.8	68.8	23.0	86.2	86.2	12.6	12.6	40.8	12.6	12.6	12.6
Actuated g/C Ratio	0.05	0.57	0.57	0.19	0.72	0.72	0.10	0.10	0.34	0.10	0.10	0.10
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2		5.2	5.2	5.2
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lane Grp Cap (vph)	83	2136	908	658	2650	1137	145	204	948	143	210	163
v/s Ratio Prot	0.04	c0.58		c0.21	0.60			0.02	c0.29		0.01	
v/s Ratio Perm			0.06			0.05	0.10			0.05		0.01
v/c Ratio	0.89	1.02	0.11	1.07	0.84	0.07	0.94	0.16	0.84	0.44	0.10	0.05
Uniform Delay, d1	56.9	25.6	11.7	48.5	12.1	5.0	53.4	48.9	36.7	50.4	48.6	48.3
Progression Factor	0.86	0.77	0.49	1.01	0.79	0.78	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	54.6	22.8	0.2	35.5	0.3	0.0	57.3	0.1	6.7	0.8	0.1	0.0
Delay (s)	103.8	42.5	5.9	84.4	9.8	3.9	110.7	49.0	43.3	51.2	48.6	48.4
Level of Service	F	D	A	F	A	A	F	D	D	D	D	D
Approach Delay (s)		41.9			26.9			53.0			49.5	
Approach LOS		D			C			D			D	

Intersection Summary			
HCM Average Control Delay	36.8	HCM Level of Service	D
HCM Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.6
Intersection Capacity Utilization	103.3%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action
8: US-56 & I-35 SB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	2770	90	320	1440	0	0	0	0	210	0	1400
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		1.00		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3509		1719	3725					1736		2760
Flt Permitted		1.00		0.08	1.00					0.95		1.00
Satd. Flow (perm)		3509		142	3725					1736		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2916	95	337	1516	0	0	0	0	221	0	1474
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	3009	0	337	1516	0	0	0	0	221	0	1474
Heavy Vehicles (%)	0%	2%	14%	5%	2%	0%	0%	0%	0%	4%	0%	3%
Turn Type				pm+pt						custom		custom
Protected Phases		2		1	6					4		5
Permitted Phases				6						4		4
Actuated Green, G (s)		80.0		64.0	51.0					12.0		54.0
Effective Green, g (s)		80.0		64.0	51.0					12.0		54.0
Actuated g/C Ratio		0.67		0.53	0.42					0.10		0.45
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2339		247	1583					174		1357
v/s Ratio Prot		c0.86		0.15	0.41					0.13		c0.38
v/s Ratio Perm				c0.58								0.15
v/c Ratio		1.29		1.36	0.96					1.27		1.09
Uniform Delay, d1		20.0		50.2	33.5					54.0		33.0
Progression Factor		1.11		1.08	1.20					1.00		1.00
Incremental Delay, d2		129.9		180.7	10.4					158.8		51.4
Delay (s)		152.0		234.9	50.7					212.8		84.4
Level of Service		F		F	D					F		F
Approach Delay (s)		152.0			84.2			0.0			101.1	
Approach LOS		F			F			A			F	

Intersection Summary			
HCM Average Control Delay	119.7	HCM Level of Service	F
HCM Volume to Capacity ratio	1.32		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	120.5%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action

9: US-56 & I-35 NB Ramps

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑			↑↑	↱	↰	↱	↱			
Volume (vph)	0	1300	0	0	1600	550	170	0	720	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95	0.95			
Frt		1.00			1.00	0.85	1.00	0.85	0.85			
Flt Protected		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (prot)		3725			3539	1583	1687	1490	1490			
Flt Permitted		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (perm)		3725			3539	1583	1687	1490	1490			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1368	0	0	1684	579	179	0	758	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	108	0	21	21	0	0	0
Lane Group Flow (vph)	0	1368	0	0	1684	471	179	358	358	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	2%	7%	0%	3%	0%	0%	0%
Turn Type						Perm	Perm		Perm			
Protected Phases		2			6			8				
Permitted Phases						6	8		8			
Actuated Green, G (s)		74.2			74.2	74.2	35.8	35.8	35.8			
Effective Green, g (s)		74.2			74.2	74.2	35.8	35.8	35.8			
Actuated g/C Ratio		0.62			0.62	0.62	0.30	0.30	0.30			
Clearance Time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0	3.0			
Lane Grp Cap (vph)		2303			2188	979	503	445	445			
v/s Ratio Prot		0.37			c0.48			c0.24				
v/s Ratio Perm						0.30	0.11		0.24			
v/c Ratio		0.59			0.77	0.48	0.36	0.80	0.80			
Uniform Delay, d1		13.8			16.7	12.4	33.0	38.9	38.9			
Progression Factor		0.71			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2		0.1			1.7	0.4	0.4	10.1	10.1			
Delay (s)		10.0			18.4	12.8	33.5	49.0	49.0			
Level of Service		A			B	B	C	D	D			
Approach Delay (s)		10.0			16.9			46.0			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	20.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	106.7%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action

10: Santa Fe & Moonlight Road

AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰	↱	↑↱		↰	↑↑
Volume (vph)	120	320	710	240	460	410
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.96		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3380		1770	3505
Flt Permitted	0.95	1.00	1.00		0.21	1.00
Satd. Flow (perm)	1770	1583	3380		396	3505
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	126	337	747	253	484	432
RTOR Reduction (vph)	0	298	20	0	0	0
Lane Group Flow (vph)	126	39	980	0	484	432
Heavy Vehicles (%)	2%	2%	3%	2%	2%	3%
Turn Type		Perm			pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8			6	
Actuated Green, G (s)	13.8	13.8	64.4		96.2	96.2
Effective Green, g (s)	13.8	13.8	64.4		96.2	96.2
Actuated g/C Ratio	0.12	0.12	0.54		0.80	0.80
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	204	182	1814		624	2810
v/s Ratio Prot	c0.07		0.29		c0.17	0.12
v/s Ratio Perm		0.02			c0.45	
v/c Ratio	0.62	0.21	0.54		0.78	0.15
Uniform Delay, d1	50.6	48.2	18.1		18.5	2.7
Progression Factor	1.00	1.00	1.00		0.74	0.81
Incremental Delay, d2	5.5	0.6	1.2		5.1	0.1
Delay (s)	56.1	48.8	19.3		18.9	2.3
Level of Service	E	D	B		B	A
Approach Delay (s)	50.7		19.3			11.0
Approach LOS	D		B			B

Intersection Summary			
HCM Average Control Delay	22.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	71.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action

11: Waverly Road & US 56

AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰	↑↑	↱	↰↰	↑↱		↰	↑↑	↱	↰	↑↑	↱
Volume (vph)	0	110	10	560	110	50	80	190	0	10	90	360
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor		0.95	1.00	0.97	0.95		1.00	0.95		1.00	0.95	1.00
Frt		1.00	0.85	1.00	0.95		1.00	1.00		1.00	1.00	0.85
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)		3539	1615	3400	3312		1736	3406		1805	3059	1568
Flt Permitted		1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)		3539	1615	3400	3312		1736	3406		1805	3059	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	116	11	589	116	53	84	200	0	11	95	379
RTOR Reduction (vph)	0	0	10	0	33	0	0	0	0	0	0	242
Lane Group Flow (vph)	0	116	1	589	136	0	84	200	0	11	95	137
Heavy Vehicles (%)	0%	2%	0%	3%	2%	8%	4%	6%	0%	0%	18%	3%
Turn Type	Prot		Perm	Prot			Prot		Perm	Prot		Perm
Protected Phases	3	8		7	4		5	2		1	6	
Permitted Phases			8					2	2			6
Actuated Green, G (s)		8.3	8.3	20.7	34.0		8.5	39.5		1.5	32.5	32.5
Effective Green, g (s)		8.3	8.3	20.7	34.0		8.5	39.5		1.5	32.5	32.5
Actuated g/C Ratio		0.09	0.09	0.23	0.38		0.09	0.44		0.02	0.36	0.36
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)		326	149	782	1251		164	1495		30	1105	566
v/s Ratio Prot		c0.03		c0.17	0.04		c0.05	0.06		0.01	0.03	
v/s Ratio Perm			0.00									c0.09
v/c Ratio		0.36	0.01	0.75	0.11		0.51	0.13		0.37	0.09	0.24
Uniform Delay, d1		38.3	37.1	32.3	18.2		38.8	15.1		43.8	19.0	20.1
Progression Factor		1.01	1.03	0.94	0.84		0.85	0.77		1.32	0.56	0.99
Incremental Delay, d2		0.7	0.0	3.7	0.0		2.6	0.2		6.5	0.1	0.9
Delay (s)		39.6	38.2	34.1	15.3		35.4	11.7		64.3	10.8	20.8
Level of Service		D	D	C	B		D	B		E	B	C
Approach Delay (s)		39.4			29.9			18.7			19.8	
Approach LOS		D			C			B			B	

Intersection Summary			
HCM Average Control Delay	25.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	42.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action

12: 183rd Street & Four Corners Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✥			✥			✥			✥	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	20	20	5	40	5	40	100	5	10	160	5
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	21	21	5	42	5	42	105	5	11	168	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	47	53	153	184
Volume Left (vph)	5	5	42	11
Volume Right (vph)	21	5	5	5
Hadj (s)	-0.24	0.00	0.07	0.03
Departure Headway (s)	4.5	4.7	4.4	4.3
Degree Utilization, x	0.06	0.07	0.19	0.22
Capacity (veh/h)	733	700	786	798
Control Delay (s)	7.8	8.1	8.4	8.6
Approach Delay (s)	7.8	8.1	8.4	8.6
Approach LOS	A	A	A	A

Intersection Summary			
Delay	8.4		
HCM Level of Service	A		
Intersection Capacity Utilization	30.5%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner No Action - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner No-Action
13: 183rd Street & US 56 — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	20	20	5	20	20	5	0	250	20	5	110	30
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	21	5	21	21	5	0	263	21	5	116	32
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	432	426	132	432	432	274	147			284		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	432	426	132	432	432	274	147			284		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	96	96	99	96	96	99	100			100		
cM capacity (veh/h)	516	521	923	517	518	770	1447			1290		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	47	47	284	153
Volume Left	21	21	0	5
Volume Right	5	5	21	32
cSH	545	537	1447	1290
Volume to Capacity	0.09	0.09	0.00	0.00
Queue Length 95th (ft)	7	7	0	0
Control Delay (s)	12.2	12.4	0.0	0.3
Lane LOS	B	B		A
Approach Delay (s)	12.2	12.4	0.0	0.3
Approach LOS	B	B		

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	24.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action
14: 183rd Street & Waverly Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	20	20	5	20	20	10	5	200	20	10	170	30
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	21	5	21	21	11	5	211	21	11	179	32
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	32			26			255	139	24	261	137	26
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	32			26			255	139	24	261	137	26
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			99			99	71	98	98	76	97
cM capacity (veh/h)	1594			1601			542	732	1059	521	734	1047

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	47	53	237	221
Volume Left	21	21	5	11
Volume Right	5	11	21	32
cSH	1594	1601	747	752
Volume to Capacity	0.01	0.01	0.32	0.29
Queue Length 95th (ft)	1	1	34	31
Control Delay (s)	3.3	3.0	12.0	11.8
Lane LOS	A	A	B	B
Approach Delay (s)	3.3	3.0	12.0	11.8
Approach LOS			B	B

Intersection Summary			
Average Delay	10.3		
Intersection Capacity Utilization	25.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action
15: 183rd Street & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	120	80	140	240	110	120	90	1120	210	100	960	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.90		1.00	0.92		1.00	0.98		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1679		1770	1717		1770	3427		1770	3485	
Flt Permitted	0.50	1.00		0.24	1.00		0.20	1.00		0.10	1.00	
Satd. Flow (perm)	927	1679		444	1717		365	3427		193	3485	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	126	84	147	253	116	126	95	1179	221	105	1011	116
RTOR Reduction (vph)	0	73	0	0	0	0	0	16	0	0	9	0
Lane Group Flow (vph)	126	158	0	253	242	0	95	1384	0	105	1118	0
Heavy Vehicles (%)	2%	3%	2%	2%	2%	2%	2%	3%	2%	2%	2%	2%
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	18.9	12.9		26.9	16.9		42.7	42.7		43.1	43.1	
Effective Green, g (s)	18.9	12.9		26.9	16.9		42.7	42.7		43.1	43.1	
Actuated g/C Ratio	0.21	0.14		0.30	0.19		0.47	0.47		0.48	0.48	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	251	241		280	322		236	1626		170	1669	
v/s Ratio Prot	0.03	0.09		c0.10	0.14		0.02	c0.40		0.03	c0.32	
v/s Ratio Perm	0.07			c0.17			0.17			0.27		
v/c Ratio	0.50	0.66		0.90	0.75		0.40	0.85		0.62	0.67	
Uniform Delay, d1	30.3	36.5		27.0	34.6		21.8	20.8		19.5	18.0	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		0.70	0.86	
Incremental Delay, d2	1.6	6.3		29.9	9.5		1.1	5.8		4.9	1.6	
Delay (s)	31.7	42.7		57.0	44.1		22.9	26.7		18.4	17.0	
Level of Service	C	D		E	D		C	C		B	B	
Approach Delay (s)		38.8			50.7			26.4			17.1	
Approach LOS		D			D			C			B	

Intersection Summary			
HCM Average Control Delay	27.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	86.0%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action
16: Four Corners Road & US 56 — AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	110	70	0	140	50	30	190	0	60	80	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	116	74	0	147	53	32	200	0	63	84	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	600	474	200	605	474	84	84			200		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	600	474	200	605	474	84	84			200		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	75	91	100	68	95	98			95		
cM capacity (veh/h)	281	457	843	288	457	975	1506			1372		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	195	200	232	147
Volume Left	5	0	32	63
Volume Right	74	53	0	0
cSH	542	531	1506	1372
Volume to Capacity	0.36	0.38	0.02	0.05
Queue Length 95th (ft)	41	43	2	4
Control Delay (s)	15.3	15.8	1.2	3.5
Lane LOS	C	C	A	A
Approach Delay (s)	15.3	15.8	1.2	3.5
Approach LOS	C	C		

Intersection Summary			
Average Delay	9.0		
Intersection Capacity Utilization	39.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action
17: 191st Street & US 56 — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	20	10	5	5	10	5	0	200	10	0	70	60
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	11	5	5	11	5	0	211	11	0	74	63
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	332	326	105	332	353	216	137			221		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	332	326	105	332	353	216	137			221		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	98	99	99	98	99	100			100		
cM capacity (veh/h)	613	595	955	614	575	829	1460			1360		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	37	21	221	137
Volume Left	21	5	0	0
Volume Right	5	5	11	63
cSH	640	634	1460	1360
Volume to Capacity	0.06	0.03	0.00	0.00
Queue Length 95th (ft)	5	3	0	0
Control Delay (s)	11.0	10.9	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	11.0	10.9	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	21.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action
18: 191st Street & Four Corners Road — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	5	15	190	10	105	105
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	16	200	11	111	111
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	537	205			211	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	537	205			211	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	98			92	
cM capacity (veh/h)	467	840			1360	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	21	211	221
Volume Left	5	0	111
Volume Right	16	11	0
cSH	700	1700	1360
Volume to Capacity	0.03	0.12	0.08
Queue Length 95th (ft)	2	0	7
Control Delay (s)	10.3	0.0	4.3
Lane LOS	B		A
Approach Delay (s)	10.3	0.0	4.3
Approach LOS	B		

Intersection Summary			
Average Delay	2.6		
Intersection Capacity Utilization	35.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action
19: 191st Street & Waverly Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	60	5	10	40	10	5	40	30	10	20	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	63	5	11	42	11	5	42	32	11	21	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	53			68			161	150	66	197	147	47
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	53			68			161	150	66	197	147	47
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			99			99	94	97	99	97	99
cM capacity (veh/h)	1566			1546			782	732	995	704	740	1027

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	74	63	79	37
Volume Left	5	11	5	11
Volume Right	5	11	32	5
cSH	1566	1546	823	759
Volume to Capacity	0.00	0.01	0.10	0.05
Queue Length 95th (ft)	0	1	8	4
Control Delay (s)	0.5	1.3	9.8	10.0
Lane LOS	A	A	A	A
Approach Delay (s)	0.5	1.3	9.8	10.0
Approach LOS			A	A

Intersection Summary			
Average Delay	5.0		
Intersection Capacity Utilization	17.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action
20: W 188th Street & Gardner Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	30	220	210	30	240	210	970	260	260	1250	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00		1.00	0.95		0.91	0.91	1.00
Frt	1.00	1.00	0.85	1.00	0.87		1.00	0.97		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1787	1845	1583	1770	1613		1736	3523		1610	3531	1553
Flt Permitted	0.24	1.00	1.00	0.74	1.00		0.19	1.00		0.09	0.88	1.00
Satd. Flow (perm)	452	1845	1583	1370	1613		349	3523		161	3119	1553
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	74	33	232	228	33	261	221	1021	283	283	1316	105
RTOR Reduction (vph)	0	0	71	0	210	0	0	18	0	0	0	32
Lane Group Flow (vph)	74	33	161	228	84	0	221	1286	0	255	1344	73
Heavy Vehicles (%)	1%	3%	2%	2%	3%	2%	4%	5%	2%	2%	3%	4%
Turn Type	Perm		Perm	Perm			pm+pt			pm+pt		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	23.6	23.6	23.6	23.6	23.6		72.3	61.0		86.4	86.4	70.1
Effective Green, g (s)	23.6	23.6	23.6	23.6	23.6		72.3	61.0		86.4	86.4	70.1
Actuated g/C Ratio	0.20	0.20	0.20	0.20	0.20		0.60	0.51		0.72	0.72	0.58
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	89	363	311	269	317		341	1791		362	2316	907
v/s Ratio Prot		0.02			0.05		0.06	0.36		c0.12	c0.10	
v/s Ratio Perm	0.16		0.10	c0.17			0.33			c0.39	0.32	0.05
v/c Ratio	0.83	0.09	0.52	0.85	0.27		0.65	0.72		0.70	0.58	0.08
Uniform Delay, d1	46.3	39.4	43.1	46.5	40.9		10.9	22.8		27.2	8.1	10.9
Progression Factor	1.00	1.00	1.00	1.00	1.00		0.97	1.01		1.00	1.00	1.00
Incremental Delay, d2	45.4	0.1	1.4	21.2	0.5		0.4	0.2		6.1	0.4	0.2
Delay (s)	91.7	39.5	44.5	67.6	41.3		10.9	23.2		33.3	8.5	11.1
Level of Service	F	D	D	E	D		B	C		C	A	B
Approach Delay (s)		54.4			52.8			21.4			12.3	
Approach LOS		D			D			C			B	

Intersection Summary			
HCM Average Control Delay	24.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	107.6%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action

21: I-35 SB Ramps & Gardner Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	210	0	620	10	820	0	0	1510	170
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)				5.0		5.0		5.0			5.0	5.0
Lane Util. Factor				1.00		1.00		1.00			1.00	1.00
Frt				1.00		0.85		1.00			1.00	0.85
Flt Protected				0.95		1.00		1.00			1.00	1.00
Satd. Flow (prot)				1703		1495		1941			1961	1553
Flt Permitted				0.95		1.00		0.57			1.00	1.00
Satd. Flow (perm)				1703		1495		1112			1961	1553
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	221	0	653	11	863	0	0	1589	179
RTOR Reduction (vph)	0	0	0	0	0	166	0	0	0	0	0	37
Lane Group Flow (vph)	0	0	0	221	0	487	0	874	0	0	1589	142
Heavy Vehicles (%)	0%	0%	0%	6%	0%	8%	0%	3%	0%	0%	2%	4%
Turn Type				Prot		custom	Perm					Perm
Protected Phases				3				2			6	
Permitted Phases						3	2					6
Actuated Green, G (s)				27.0		27.0		83.0			83.0	83.0
Effective Green, g (s)				27.0		27.0		83.0			83.0	83.0
Actuated g/C Ratio				0.22		0.22		0.69			0.69	0.69
Clearance Time (s)				5.0		5.0		5.0			5.0	5.0
Vehicle Extension (s)				3.0		3.0		3.0			3.0	3.0
Lane Grp Cap (vph)				383		336		769			1356	1074
v/s Ratio Prot				0.13							c0.81	
v/s Ratio Perm						c0.33		0.79				0.09
v/c Ratio				0.58		1.45		1.14			1.17	0.13
Uniform Delay, d1				41.4		46.5		18.5			18.5	6.3
Progression Factor				1.00		1.00		0.78			1.13	0.77
Incremental Delay, d2				2.1		218.4		63.1			84.0	0.2
Delay (s)				43.5		264.9		77.6			104.9	5.1
Level of Service				D		F		E			F	A
Approach Delay (s)		0.0			208.9			77.6			94.8	
Approach LOS		A			F			E			F	

Intersection Summary			
HCM Average Control Delay	118.9	HCM Level of Service	F
HCM Volume to Capacity ratio	1.24		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	94.6%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action

22: I-35 NB Ramps & Gardner Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	380	0	40	0	0	0	0	450	460	1060	660	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.99						0.93			1.00	
Flt Protected		0.96						1.00			0.97	
Satd. Flow (prot)		1754						1809			1902	
Flt Permitted		0.96						1.00			0.97	
Satd. Flow (perm)		1754						1809			1902	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	400	0	42	0	0	0	0	474	484	1116	695	0
RTOR Reduction (vph)	0	3	0	0	0	0	0	31	0	0	0	0
Lane Group Flow (vph)	0	439	0	0	0	0	0	927	0	0	1811	0
Heavy Vehicles (%)	2%	0%	5%	0%	0%	0%	0%	4%	2%	2%	2%	0%
Turn Type	Split									Split		
Protected Phases	4	4						2		6	6	
Permitted Phases												
Actuated Green, G (s)		20.0						30.0			55.0	
Effective Green, g (s)		20.0						30.0			55.0	
Actuated g/C Ratio		0.17						0.25			0.46	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		292						452			872	
v/s Ratio Prot		c0.25						c0.51			c0.95	
v/s Ratio Perm												
v/c Ratio		1.50						2.05			2.08	
Uniform Delay, d1		50.0						45.0			32.5	
Progression Factor		1.00						1.00			0.69	
Incremental Delay, d2		243.2						480.8			484.9	
Delay (s)		293.2						525.8			507.4	
Level of Service		F						F			F	
Approach Delay (s)		293.2			0.0			525.8			507.4	
Approach LOS		F			A			F			F	

Intersection Summary			
HCM Average Control Delay	483.4	HCM Level of Service	F
HCM Volume to Capacity ratio	1.96		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	174.0%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action

23: E 191st Street & Gardner Rd — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	20	80	830	20	100	600
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	84	874	21	105	632
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						1000
pX, platoon unblocked	0.58					
vC, conflicting volume	1726	884			895	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1892	884			895	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	46	75			86	
cM capacity (veh/h)	39	343			746	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	105	895	737
Volume Left	21	0	105
Volume Right	84	21	0
cSH	133	1700	746
Volume to Capacity	0.79	0.53	0.14
Queue Length 95th (ft)	119	0	12
Control Delay (s)	93.7	0.0	3.6
Lane LOS	F		A
Approach Delay (s)	93.7	0.0	3.6
Approach LOS	F		

Intersection Summary			
Average Delay	7.2		
Intersection Capacity Utilization	98.0%	ICU Level of Service	F
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action

24: Sunflower Road & US 56 — AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	5	20	5	270	30	5	5	200	360	10	60	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.98			1.00			0.91			1.00	
Flt Protected		0.99			0.96			1.00			0.99	
Satd. Flow (prot)		1844			1779			1669			1635	
Flt Permitted		0.95			0.73			1.00			0.92	
Satd. Flow (perm)		1762			1353			1667			1523	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	5	21	5	284	32	5	5	211	379	11	63	0
RTOR Reduction (vph)	0	4	0	0	1	0	0	59	0	0	0	0
Lane Group Flow (vph)	0	27	0	0	320	0	0	536	0	0	74	0
Heavy Vehicles (%)	0%	0%	0%	2%	3%	0%	0%	6%	3%	0%	18%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		26.0			26.0			54.0			54.0	
Effective Green, g (s)		26.0			26.0			54.0			54.0	
Actuated g/C Ratio		0.29			0.29			0.60			0.60	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		509			391			1000			914	
v/s Ratio Prot												
v/s Ratio Perm		0.02			c0.24			c0.32			0.05	
v/c Ratio		0.05			0.82			0.54			0.08	
Uniform Delay, d1		23.1			29.8			10.6			7.6	
Progression Factor		1.00			0.69			0.99			1.18	
Incremental Delay, d2		0.0			11.6			1.8			0.2	
Delay (s)		23.2			32.0			12.3			9.1	
Level of Service		C			C			B			A	
Approach Delay (s)		23.2			32.0			12.3			9.1	
Approach LOS		C			C			B			A	

Intersection Summary			
HCM Average Control Delay	18.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	65.3%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action

25: US 56 & 4th Street — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	480	130	80	250	110	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0			5.0	5.0	
Lane Util. Factor	1.00			1.00	1.00	
Frt	0.97			1.00	0.94	
Flt Protected	1.00			0.99	0.97	
Satd. Flow (prot)	1778			1779	1672	
Flt Permitted	1.00			0.77	0.97	
Satd. Flow (perm)	1778			1379	1672	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	505	137	84	263	116	84
RTOR Reduction (vph)	9	0	0	0	32	0
Lane Group Flow (vph)	633	0	0	347	168	0
Heavy Vehicles (%)	4%	3%	4%	6%	5%	3%
Turn Type			Perm			
Protected Phases	4			8	2	
Permitted Phases			8			
Actuated Green, G (s)	65.9			65.9	14.1	
Effective Green, g (s)	65.9			65.9	14.1	
Actuated g/C Ratio	0.73			0.73	0.16	
Clearance Time (s)	5.0			5.0	5.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	1302			1010	262	
v/s Ratio Prot	c0.36				c0.10	
v/s Ratio Perm				0.25		
v/c Ratio	0.49			0.34	0.64	
Uniform Delay, d1	5.0			4.3	35.6	
Progression Factor	1.00			0.35	1.00	
Incremental Delay, d2	1.3			0.8	5.3	
Delay (s)	6.3			2.3	40.9	
Level of Service	A			A	D	
Approach Delay (s)	6.3			2.3	40.9	
Approach LOS	A			A	D	

Intersection Summary			
HCM Average Control Delay	11.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	74.2%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action

26: 199th Street & Four Corners Road — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	390	320	100	100	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	11	411	337	105	105	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	442				821	389
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	442				821	389
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				69	99
cM capacity (veh/h)	1129				341	663

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	421	442	111
Volume Left	11	0	105
Volume Right	0	105	5
cSH	1129	1700	349
Volume to Capacity	0.01	0.26	0.32
Queue Length 95th (ft)	1	0	33
Control Delay (s)	0.3	0.0	20.0
Lane LOS	A		C
Approach Delay (s)	0.3	0.0	20.0
Approach LOS			C

Intersection Summary			
Average Delay	2.4		
Intersection Capacity Utilization	41.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action

27: 199th Street & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	210	10	30	170	430	10	260	20	260	90	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00		1.00		1.00	1.00	1.00
Frt	1.00	0.99		1.00	1.00	0.85		0.99		1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		1.00		0.95	1.00	1.00
Satd. Flow (prot)	1752	1834		1752	1863	1583		1830		1770	1863	1583
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.99		0.45	1.00	1.00
Satd. Flow (perm)	1752	1834		1752	1863	1583		1818		830	1863	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	32	221	11	32	179	453	11	274	21	274	95	53
RTOR Reduction (vph)	0	2	0	0	0	368	0	2	0	0	0	21
Lane Group Flow (vph)	32	230	0	32	179	85	0	304	0	274	95	32
Heavy Vehicles (%)	3%	3%	0%	3%	2%	2%	0%	3%	0%	2%	2%	2%
Turn Type	Prot			Prot		Perm	Perm			pm+pt		Perm
Protected Phases	5	2		1	6			8		7	4	
Permitted Phases						6	8			4		4
Actuated Green, G (s)	4.2	16.4		4.6	16.8	16.8		37.1		54.0	54.0	54.0
Effective Green, g (s)	4.2	16.4		4.6	16.8	16.8		37.1		54.0	54.0	54.0
Actuated g/C Ratio	0.05	0.18		0.05	0.19	0.19		0.41		0.60	0.60	0.60
Clearance Time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	82	334		90	348	295		749		622	1118	950
v/s Ratio Prot	0.02	c0.13		0.02	c0.10					c0.06	0.05	
v/s Ratio Perm						0.05		0.17		c0.21		0.02
v/c Ratio	0.39	0.69		0.36	0.51	0.29		0.41		0.44	0.08	0.03
Uniform Delay, d1	41.7	34.4		41.3	32.9	31.5		18.7		9.8	7.6	7.3
Progression Factor	1.12	1.00		1.00	1.00	1.00		1.00		1.00	1.00	1.00
Incremental Delay, d2	3.0	5.8		2.4	1.3	0.5		1.6		0.5	0.1	0.1
Delay (s)	49.7	40.2		43.7	34.2	32.0		20.3		10.3	7.7	7.4
Level of Service	D	D		D	C	C		C		B	A	A
Approach Delay (s)		41.3			33.2			20.3			9.3	
Approach LOS		D			C			C			A	

Intersection Summary			
HCM Average Control Delay	26.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	61.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action

28: I-35 SB Ramps & Sunflower Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	20	0	150	10	180	0	0	580	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)					5.0			5.0			5.0	
Lane Util. Factor					1.00			1.00			1.00	
Frt					0.88			1.00			0.98	
Flt Protected					0.99			1.00			1.00	
Satd. Flow (prot)					1603			1777			1830	
Flt Permitted					0.99			0.97			1.00	
Satd. Flow (perm)					1603			1721			1830	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	21	0	158	11	189	0	0	611	84
RTOR Reduction (vph)	0	0	0	0	144	0	0	0	0	0	3	0
Lane Group Flow (vph)	0	0	0	0	35	0	0	200	0	0	692	0
Heavy Vehicles (%)	0%	0%	0%	10%	0%	3%	0%	7%	0%	0%	2%	3%
Turn Type				custom			Perm					
Protected Phases				6	6			8			4	
Permitted Phases				6			8					
Actuated Green, G (s)					8.1			71.9			71.9	
Effective Green, g (s)					8.1			71.9			71.9	
Actuated g/C Ratio					0.09			0.80			0.80	
Clearance Time (s)					5.0			5.0			5.0	
Vehicle Extension (s)					3.0			3.0			3.0	
Lane Grp Cap (vph)					144			1375			1462	
v/s Ratio Prot					c0.02						c0.38	
v/s Ratio Perm								0.12				
v/c Ratio					0.24			0.15			0.47	
Uniform Delay, d1					38.1			2.1			2.9	
Progression Factor					1.00			0.73			1.00	
Incremental Delay, d2					0.9			0.2			1.1	
Delay (s)					39.0			1.7			4.0	
Level of Service					D			A			A	
Approach Delay (s)		0.0			39.0			1.7			4.0	
Approach LOS		A			D			A			A	

Intersection Summary			
HCM Average Control Delay	9.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	54.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action

29: I-35 NB Ramps & Sunflower Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	150	0	10	0	0	0	0	40	110	570	40	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.99						0.90			1.00	
Flt Protected		0.96						1.00			0.96	
Satd. Flow (prot)		1704						1652			1773	
Flt Permitted		0.96						1.00			0.63	
Satd. Flow (perm)		1704						1652			1171	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	158	0	11	0	0	0	0	42	116	600	42	0
RTOR Reduction (vph)	0	3	0	0	0	0	0	30	0	0	0	0
Lane Group Flow (vph)	0	166	0	0	0	0	0	128	0	0	642	0
Heavy Vehicles (%)	6%	0%	0%	0%	0%	0%	0%	8%	2%	2%	8%	0%
Turn Type	Perm									Perm		
Protected Phases		2						8			4	
Permitted Phases	2									4		
Actuated Green, G (s)		13.3						66.7			66.7	
Effective Green, g (s)		13.3						66.7			66.7	
Actuated g/C Ratio		0.15						0.74			0.74	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		252						1224			868	
v/s Ratio Prot								0.08				
v/s Ratio Perm		0.10									c0.55	
v/c Ratio		0.66						0.10			0.74	
Uniform Delay, d1		36.2						3.3			6.7	
Progression Factor		1.00						1.00			0.69	
Incremental Delay, d2		6.4						0.2			5.1	
Delay (s)		42.6						3.4			9.7	
Level of Service		D						A			A	
Approach Delay (s)		42.6			0.0			3.4			9.7	
Approach LOS		D			A			A			A	

Intersection Summary			
HCM Average Control Delay	14.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action

30: US-56 & I-35 NB Loop

AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	1310	1670	0	1760	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	1379	1758	0	1853	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked					0.62	
vC, conflicting volume			3137		2305	689
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			3137		1878	689
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			103		40	393

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	689	689	1758	926	926
Volume Left	0	0	0	0	0
Volume Right	0	0	1758	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.41	0.41	1.03	0.54	0.54
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	106.7%	ICU Level of Service	G
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action

37: 199th Street & West Waverley

AM Peak Hour

Movement	EBL	EBT	WBU	WBT	WBR	SBL	SBR
Lane Configurations							
Volume (veh/h)	10	730	0	670	60	30	10
Sign Control		Free		Free		Stop	
Grade		0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	793	0	728	65	33	11
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type		TWLTL		TWLTL			
Median storage veh)		2		2			
Upstream signal (ft)				802			
pX, platoon unblocked	0.98		0.00			0.98	0.98
vC, conflicting volume	793		0			1576	761
vC1, stage 1 conf vol						761	
vC2, stage 2 conf vol						815	
vCu, unblocked vol	781		0			1577	748
tC, single (s)	4.1		0.0			6.4	6.2
tC, 2 stage (s)						5.4	
tF (s)	2.2		0.0			3.5	3.3
p0 queue free %	99		0			90	97
cM capacity (veh/h)	831		0			329	404

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	11	793	793	0	43
Volume Left	11	0	0	0	33
Volume Right	0	0	65	0	11
cSH	831	1700	1700	1700	345
Volume to Capacity	0.01	0.47	0.47	0.00	0.13
Queue Length 95th (ft)	1	0	0	0	11
Control Delay (s)	9.4	0.0	0.0	0.0	16.9
Lane LOS	A				C
Approach Delay (s)	0.1		0.0		16.9
Approach LOS					C

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	48.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action

38: 199th Street & IH-35 SB Ramp

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	700	60	50	280	0	0	0	0	10	0	460
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		1.00		1.00	1.00					1.00		1.00
Frt		0.99		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		1843		1770	1863					1805		1583
Flt Permitted		1.00		0.29	1.00					0.95		1.00
Satd. Flow (perm)		1843		549	1863					1805		1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	761	65	54	304	0	0	0	0	11	0	500
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	445
Lane Group Flow (vph)	0	824	0	54	304	0	0	0	0	11	0	55
Heavy Vehicles (%)	0%	2%	2%	2%	2%	0%	0%	0%	0%	0%	0%	2%
Turn Type				Perm						custom		custom
Protected Phases		4			8							
Permitted Phases				8						6		6
Actuated Green, G (s)		70.1		70.1	70.1					9.9		9.9
Effective Green, g (s)		70.1		70.1	70.1					9.9		9.9
Actuated g/C Ratio		0.78		0.78	0.78					0.11		0.11
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		1435		428	1451					199		174
v/s Ratio Prot		c0.45			0.16							
v/s Ratio Perm				0.10						0.01		c0.03
v/c Ratio		0.57		0.13	0.21					0.06		0.32
Uniform Delay, d1		4.0		2.4	2.6					35.9		36.9
Progression Factor		0.94		0.78	0.79					1.00		1.00
Incremental Delay, d2		1.6		0.6	0.3					0.1		1.0
Delay (s)		5.4		2.5	2.4					36.0		38.0
Level of Service		A		A	A					D		D
Approach Delay (s)		5.4			2.4			0.0			37.9	
Approach LOS		A			A			A			D	

Intersection Summary			
HCM Average Control Delay	14.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	63.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action
39: 199th Street & IH-35 NB Ramp — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	580	130	0	0	160	20	170	0	90	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0		5.0			
Lane Util. Factor	1.00	1.00			1.00		1.00		1.00			
Frt	1.00	1.00			0.98		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1770	1863			1839		1770		1583			
Flt Permitted	0.55	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	1021	1863			1839		1770		1583			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	630	141	0	0	174	22	185	0	98	0	0	0
RTOR Reduction (vph)	0	0	0	0	4	0	0	0	82	0	0	0
Lane Group Flow (vph)	630	141	0	0	192	0	185	0	16	0	0	0
Heavy Vehicles (%)	2%	2%	0%	0%	2%	0%	2%	0%	2%	0%	0%	0%
Turn Type	pm+pt						custom		custom			
Protected Phases	7	4			8							
Permitted Phases	4						2		2			
Actuated Green, G (s)	65.7	65.7			39.9		14.3		14.3			
Effective Green, g (s)	65.7	65.7			39.9		14.3		14.3			
Actuated g/C Ratio	0.73	0.73			0.44		0.16		0.16			
Clearance Time (s)	5.0	5.0			5.0		5.0		5.0			
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Lane Grp Cap (vph)	918	1360			815		281		252			
v/s Ratio Prot	c0.16	0.08			0.10							
v/s Ratio Perm	c0.34						c0.10		0.01			
v/c Ratio	0.69	0.10			0.24		0.66		0.06			
Uniform Delay, d1	5.5	3.5			15.6		35.6		32.2			
Progression Factor	0.74	0.49			0.51		1.00		1.00			
Incremental Delay, d2	1.8	0.1			0.1		5.5		0.1			
Delay (s)	5.9	1.9			8.1		41.0		32.3			
Level of Service	A	A			A		D		C			
Approach Delay (s)		5.1			8.1			38.0			0.0	
Approach LOS		A			A			D			A	

Intersection Summary			
HCM Average Control Delay	13.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	63.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action
40: 199th Street & East Waverley — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	200	10	5	160	10	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	217	11	5	174	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	820					
pX, platoon unblocked						
vC, conflicting volume			228		408	223
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			228		408	223
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	99
cM capacity (veh/h)			1352		601	822

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	228	179	16
Volume Left	0	5	11
Volume Right	11	0	5
cSH	1700	1352	660
Volume to Capacity	0.13	0.00	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.3	10.6
Lane LOS		A	B
Approach Delay (s)	0.0	0.3	10.6
Approach LOS			B

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	22.5%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)

1: 175th Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	20	570	10	10	10	310	230	10	20	150	50
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.86		1.00	0.92		1.00	0.99		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1736	1678		1805	1850		1770	3486		1805	3324	
Flt Permitted	0.74	1.00		0.29	1.00		0.62	1.00		0.60	1.00	
Satd. Flow (perm)	1357	1678		551	1850		1154	3486		1131	3324	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	21	600	11	11	11	326	242	11	21	158	53
RTOR Reduction (vph)	0	508	0	0	9	0	0	2	0	0	20	0
Lane Group Flow (vph)	74	113	0	11	13	0	326	251	0	21	191	0
Heavy Vehicles (%)	4%	0%	2%	0%	0%	0%	2%	3%	0%	0%	4%	6%
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	13.8	13.8		13.8	13.8		66.2	59.2		54.5	52.5	
Effective Green, g (s)	13.8	13.8		13.8	13.8		66.2	59.2		54.5	52.5	
Actuated g/C Ratio	0.15	0.15		0.15	0.15		0.74	0.66		0.61	0.58	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	208	257		84	284		908	2293		700	1939	
v/s Ratio Prot		c0.07			0.01		c0.03	0.07		0.00	0.06	
v/s Ratio Perm	0.05			0.02			c0.23			0.02		
v/c Ratio	0.36	0.44		0.13	0.04		0.36	0.11		0.03	0.10	
Uniform Delay, d1	34.1	34.6		32.9	32.5		4.4	5.7		7.1	8.3	
Progression Factor	1.00	1.00		1.00	1.00		0.47	0.39		1.00	1.00	
Incremental Delay, d2	1.0	1.2		0.7	0.1		0.2	0.1		0.0	0.1	
Delay (s)	35.2	35.8		33.6	32.5		2.3	2.3		7.2	8.4	
Level of Service	D	D		C	C		A	A		A	A	
Approach Delay (s)		35.7			32.9			2.3			8.3	
Approach LOS		D			C			A			A	

Intersection Summary			
HCM Average Control Delay	19.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.37		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	69.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)

2: US 56 & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	130	780	60	180	430	220	80	1040	310	370	850	120
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3619	1583	1687	3551	1538	1752	3689	1553	3367	3444	
Flt Permitted	0.43	1.00	1.00	0.16	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	793	3619	1583	283	3551	1538	1752	3689	1553	3367	3444	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	821	63	189	453	232	84	1095	326	389	895	126
RTOR Reduction (vph)	0	0	42	0	0	167	0	0	120	0	12	0
Lane Group Flow (vph)	137	821	21	189	453	65	84	1095	206	389	1009	0
Heavy Vehicles (%)	2%	5%	2%	7%	7%	5%	3%	3%	4%	4%	3%	2%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			
Actuated Green, G (s)	30.8	24.3	24.3	32.4	25.1	25.1	6.2	29.7	29.7	12.0	35.5	
Effective Green, g (s)	30.8	24.3	24.3	32.4	25.1	25.1	6.2	29.7	29.7	12.0	35.5	
Actuated g/C Ratio	0.34	0.27	0.27	0.36	0.28	0.28	0.07	0.33	0.33	0.13	0.39	
Clearance Time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	342	977	427	216	990	429	121	1217	512	449	1358	
v/s Ratio Prot	0.03	0.23		c0.07	0.13		0.05	c0.30		c0.12	0.29	
v/s Ratio Perm	0.11		0.01	c0.24		0.04			0.13			
v/c Ratio	0.40	0.84	0.05	0.88	0.46	0.15	0.69	0.90	0.40	0.87	0.74	
Uniform Delay, d1	21.2	31.0	24.3	22.6	26.8	24.4	41.0	28.7	23.3	38.2	23.3	
Progression Factor	0.47	0.57	0.31	1.32	1.06	2.57	0.73	0.58	0.22	1.00	1.00	
Incremental Delay, d2	0.7	8.1	0.2	28.9	1.4	0.7	10.6	6.2	0.3	15.9	2.2	
Delay (s)	10.6	25.7	7.8	58.7	29.9	63.6	40.5	22.9	5.3	54.2	25.6	
Level of Service	B	C	A	E	C	E	D	C	A	D	C	
Approach Delay (s)		22.6			45.1			20.1			33.5	
Approach LOS		C			D			C			C	

Intersection Summary			
HCM Average Control Delay	29.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	13.3
Intersection Capacity Utilization	84.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)

3: US 56 & Elm

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	1450	10	10	790	90	10	10	30	110	10	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			0.98		1.00	0.89		1.00	0.88	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3468			3339		1805	1651		1770	1610	
Flt Permitted		0.93			0.93		0.72	1.00		0.73	1.00	
Satd. Flow (perm)		3244			3106		1373	1651		1358	1610	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	1526	11	11	832	95	11	11	32	116	11	42
RTOR Reduction (vph)	0	0	0	0	6	0	0	28	0	0	37	0
Lane Group Flow (vph)	0	1558	0	0	932	0	11	15	0	116	16	0
Heavy Vehicles (%)	0%	4%	0%	0%	7%	2%	0%	0%	3%	2%	0%	5%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		69.5			69.5		11.5	11.5		11.5	11.5	
Effective Green, g (s)		69.5			69.5		11.5	11.5		11.5	11.5	
Actuated g/C Ratio		0.77			0.77		0.13	0.13		0.13	0.13	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2505			2399		175	211		174	206	
v/s Ratio Prot								0.01			0.01	
v/s Ratio Perm		c0.48			0.30		0.01			c0.09		
v/c Ratio		0.62			0.39		0.06	0.07		0.67	0.08	
Uniform Delay, d1		4.5			3.3		34.5	34.6		37.4	34.6	
Progression Factor		0.62			0.98		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.8			0.5		0.2	0.1		9.3	0.2	
Delay (s)		3.6			3.7		34.7	34.7		46.7	34.8	
Level of Service		A			A		C	C		D	C	
Approach Delay (s)		3.6			3.7			34.7			43.0	
Approach LOS		A			A			C			D	

Intersection Summary			
HCM Average Control Delay	6.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	74.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)

4: US 56 & Mulberry

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	1610	10	10	840	60	5	5	20	100	5	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			0.99		1.00	0.88		1.00	0.87	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3464			3339		1805	1548		1770	1612	
Flt Permitted		0.90			0.92		0.73	1.00		0.74	1.00	
Satd. Flow (perm)		3132			3090		1393	1548		1379	1612	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	42	1695	11	11	884	63	5	5	21	105	5	32
RTOR Reduction (vph)	0	0	0	0	4	0	0	19	0	0	28	0
Lane Group Flow (vph)	0	1748	0	0	954	0	5	7	0	105	9	0
Heavy Vehicles (%)	5%	4%	0%	0%	7%	8%	0%	20%	5%	2%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		70.3			70.3		10.7	10.7		10.7	10.7	
Effective Green, g (s)		70.3			70.3		10.7	10.7		10.7	10.7	
Actuated g/C Ratio		0.78			0.78		0.12	0.12		0.12	0.12	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2446			2414		166	184		164	192	
v/s Ratio Prot								0.00			0.01	
v/s Ratio Perm		c0.56			0.31		0.00			c0.08		
v/c Ratio		0.71			0.40		0.03	0.04		0.64	0.05	
Uniform Delay, d1		4.9			3.1		35.1	35.1		37.8	35.1	
Progression Factor		0.36			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.5			0.1		0.1	0.1		8.3	0.1	
Delay (s)		3.3			3.2		35.1	35.2		46.1	35.2	
Level of Service		A			A		D	D		D	D	
Approach Delay (s)		3.3			3.2			35.2			43.2	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	5.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	93.2%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
5: US 56 & Moonlight Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	170	1370	200	150	670	590	140	630	270	1210	520	110
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3654	1568	1770	3519	1583	1770	3725	1553	3433	3539	1553
Flt Permitted	0.22	1.00	1.00	0.10	1.00	1.00	0.45	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	404	3654	1568	195	3519	1583	834	3725	1553	3433	3539	1553
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	179	1442	211	158	705	621	147	663	284	1274	547	116
RTOR Reduction (vph)	0	0	58	0	0	350	0	0	75	0	0	76
Lane Group Flow (vph)	179	1442	153	158	705	271	147	663	209	1274	547	40
Heavy Vehicles (%)	2%	4%	3%	2%	8%	2%	2%	2%	4%	2%	2%	4%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		custom	Prot		Perm
Protected Phases	5	2		1	6		3	8	8	7	4	
Permitted Phases	2		2	6		6	8		8			4
Actuated Green, G (s)	50.3	41.5	41.5	43.7	38.2	38.2	25.7	17.5	17.5	32.5	41.8	41.8
Effective Green, g (s)	50.3	41.5	41.5	43.7	38.2	38.2	25.7	17.5	17.5	32.5	41.8	41.8
Actuated g/C Ratio	0.42	0.35	0.35	0.36	0.32	0.32	0.21	0.15	0.15	0.27	0.35	0.35
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	270	1264	542	143	1120	504	243	543	226	930	1233	541
v/s Ratio Prot	0.05	c0.39		c0.05	0.20		0.04	c0.18	0.13	c0.37	0.15	
v/s Ratio Perm	0.23		0.10	0.35		0.17	0.09					0.03
v/c Ratio	0.66	1.14	0.28	1.10	0.63	0.54	0.60	1.22	0.92	1.37	0.44	0.07
Uniform Delay, d1	24.3	39.2	28.4	35.9	34.9	33.6	40.4	51.2	50.6	43.8	30.1	26.2
Progression Factor	1.00	1.00	1.00	1.03	0.90	1.21	0.89	0.82	0.70	1.00	1.00	1.00
Incremental Delay, d2	4.7	73.3	1.3	102.9	2.5	3.7	2.4	112.9	34.5	173.3	0.1	0.0
Delay (s)	29.0	112.6	29.7	139.7	33.9	44.4	38.5	155.1	70.0	217.1	30.2	26.2
Level of Service	C	F	C	F	C	D	D	F	E	F	C	C
Approach Delay (s)		94.9			49.5			117.4			152.9	
Approach LOS		F			D			F			F	

Intersection Summary			
HCM Average Control Delay	105.9	HCM Level of Service	F
HCM Volume to Capacity ratio	1.23		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	114.5%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
6: Old US 56 & US 56 — AM Peak Hour

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	150	10	1880	970	10	1290
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	0.97	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	3433	1615	3654	1583	1805	3619
Flt Permitted	0.95	1.00	1.00	1.00	0.06	1.00
Satd. Flow (perm)	3433	1615	3654	1583	117	3619
Peak-hour factor, PHF	0.97	0.97	0.95	0.95	0.95	0.95
Adj. Flow (vph)	155	10	1979	1021	11	1358
RTOR Reduction (vph)	0	9	0	122	0	0
Lane Group Flow (vph)	155	1	1979	899	11	1358
Heavy Vehicles (%)	2%	0%	4%	2%	0%	5%
Turn Type		Perm		pm+ov	pm+pt	
Protected Phases	8		2	8	1	6
Permitted Phases		8	2	2	6	6
Actuated Green, G (s)	13.1	13.1	90.7	103.8	96.9	96.9
Effective Green, g (s)	13.1	13.1	90.7	103.8	96.9	96.9
Actuated g/C Ratio	0.11	0.11	0.76	0.86	0.81	0.81
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	375	176	2762	1435	111	2922
v/s Ratio Prot	0.05		c0.54	c0.07	0.00	c0.38
v/s Ratio Perm		0.00		0.50	0.08	
v/c Ratio	0.41	0.01	0.72	0.63	0.10	0.46
Uniform Delay, d1	49.9	47.6	7.8	2.4	9.4	3.6
Progression Factor	1.00	1.00	0.77	14.92	1.15	1.03
Incremental Delay, d2	0.7	0.0	0.1	0.1	0.2	0.1
Delay (s)	50.6	47.7	6.2	35.7	11.0	3.7
Level of Service	D	D	A	D	B	A
Approach Delay (s)	50.4		16.2			3.8
Approach LOS	D		B			A

Intersection Summary			
HCM Average Control Delay	13.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	71.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
7: US-56 & Cedar Niles — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	2070	160	670	2120	100	130	30	760	60	20	70
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2	5.2	5.2	5.2	5.2
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00	1.00	1.00	0.88	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1787	3725	1583	3433	3689	1583	1770	1942	2787	1752	2000	1553
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.74	1.00	1.00	0.74	1.00	1.00
Satd. Flow (perm)	1787	3725	1583	3433	3689	1583	1385	1942	2787	1358	2000	1553
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	2179	168	705	2232	105	137	32	800	63	21	74
RTOR Reduction (vph)	0	0	66	0	0	28	0	0	0	0	0	65
Lane Group Flow (vph)	74	2179	102	705	2232	77	137	32	800	63	21	9
Heavy Vehicles (%)	1%	2%	2%	2%	3%	2%	2%	3%	2%	3%	0%	4%
Turn Type	Prot		Perm	Prot		Perm	Perm		pt+ov	Perm		Perm
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases			2			6	8			4		4
Actuated Green, G (s)	5.6	68.8	68.8	23.0	86.2	86.2	12.6	12.6	40.8	12.6	12.6	12.6
Effective Green, g (s)	5.6	68.8	68.8	23.0	86.2	86.2	12.6	12.6	40.8	12.6	12.6	12.6
Actuated g/C Ratio	0.05	0.57	0.57	0.19	0.72	0.72	0.10	0.10	0.34	0.10	0.10	0.10
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2		5.2	5.2	5.2
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lane Grp Cap (vph)	83	2136	908	658	2650	1137	145	204	948	143	210	163
v/s Ratio Prot	0.04	c0.58		c0.21	0.60			0.02	c0.29		0.01	
v/s Ratio Perm			0.06			0.05	0.10			0.05		0.01
v/c Ratio	0.89	1.02	0.11	1.07	0.84	0.07	0.94	0.16	0.84	0.44	0.10	0.05
Uniform Delay, d1	56.9	25.6	11.7	48.5	12.1	5.0	53.4	48.9	36.7	50.4	48.6	48.3
Progression Factor	0.86	0.76	0.41	1.00	0.78	0.59	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	55.7	23.1	0.2	35.5	0.3	0.0	57.3	0.1	6.7	0.8	0.1	0.0
Delay (s)	104.9	42.5	5.0	83.9	9.8	3.0	110.7	49.0	43.3	51.2	48.6	48.4
Level of Service	F	D	A	F	A	A	F	D	D	D	D	D
Approach Delay (s)		41.8			26.7			53.0			49.5	
Approach LOS		D			C			D			D	

Intersection Summary			
HCM Average Control Delay	36.7	HCM Level of Service	D
HCM Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.6
Intersection Capacity Utilization	103.3%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
8: US-56 & I-35 SB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	2770	90	320	1440	0	0	0	0	210	0	1400
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		1.00		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3509		1719	3725					1736		2760
Flt Permitted		1.00		0.08	1.00					0.95		1.00
Satd. Flow (perm)		3509		142	3725					1736		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2916	95	337	1516	0	0	0	0	221	0	1474
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	3009	0	337	1516	0	0	0	0	221	0	1474
Heavy Vehicles (%)	0%	2%	14%	5%	2%	0%	0%	0%	0%	4%	0%	3%
Turn Type				pm+pt						custom		custom
Protected Phases		2		1	6					4		5
Permitted Phases				6						4		4
Actuated Green, G (s)		80.0		64.0	51.0					12.0		54.0
Effective Green, g (s)		80.0		64.0	51.0					12.0		54.0
Actuated g/C Ratio		0.67		0.53	0.42					0.10		0.45
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2339		247	1583					174		1357
v/s Ratio Prot		c0.86		0.15	0.41					0.13		c0.38
v/s Ratio Perm				c0.58								0.15
v/c Ratio		1.29		1.36	0.96					1.27		1.09
Uniform Delay, d1		20.0		50.2	33.5					54.0		33.0
Progression Factor		1.02		1.01	1.29					1.00		1.00
Incremental Delay, d2		129.9		180.3	10.2					158.8		51.4
Delay (s)		150.2		231.0	53.2					212.8		84.4
Level of Service		F		F	D					F		F
Approach Delay (s)		150.2			85.6			0.0			101.1	
Approach LOS		F			F			A			F	

Intersection Summary			
HCM Average Control Delay	119.3	HCM Level of Service	F
HCM Volume to Capacity ratio	1.32		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	120.5%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
9: US-56 & I-35 NB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑			↑↑	↱	↰	↑↱	↱			
Volume (vph)	0	1300	0	0	1600	550	170	0	720	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95	0.95			
Frt		1.00			1.00	0.85	1.00	0.85	0.85			
Flt Protected		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (prot)		3725			3539	1583	1687	1490	1490			
Flt Permitted		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (perm)		3725			3539	1583	1687	1490	1490			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1368	0	0	1684	579	179	0	758	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	112	0	0	0	0	0	0
Lane Group Flow (vph)	0	1368	0	0	1684	467	179	379	379	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	2%	7%	0%	3%	0%	0%	0%
Turn Type						Perm	Perm		Perm			
Protected Phases		2			6			8				
Permitted Phases						6	8		8			
Actuated Green, G (s)		72.6			72.6	72.6	37.4	37.4	37.4			
Effective Green, g (s)		72.6			72.6	72.6	37.4	37.4	37.4			
Actuated g/C Ratio		0.60			0.60	0.60	0.31	0.31	0.31			
Clearance Time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0	3.0			
Lane Grp Cap (vph)		2254			2141	958	526	464	464			
v/s Ratio Prot		0.37			c0.48			c0.25				
v/s Ratio Perm						0.29	0.11		0.25			
v/c Ratio		0.61			0.79	0.49	0.34	0.82	0.82			
Uniform Delay, d1		14.8			17.9	13.3	31.8	38.1	38.1			
Progression Factor		0.57			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2		0.1			2.0	0.4	0.4	10.7	10.7			
Delay (s)		8.6			19.8	13.7	32.2	48.8	48.8			
Level of Service		A			B	B	C	D	D			
Approach Delay (s)		8.6			18.3			45.6			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	21.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	106.7%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
10: Santa Fe & Moonlight Road — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰	↱	↑↱		↰	↑↑
Volume (vph)	120	320	710	240	460	410
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.96		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3380		1770	3505
Flt Permitted	0.95	1.00	1.00		0.21	1.00
Satd. Flow (perm)	1770	1583	3380		396	3505
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	126	337	747	253	484	432
RTOR Reduction (vph)	0	298	20	0	0	0
Lane Group Flow (vph)	126	39	980	0	484	432
Heavy Vehicles (%)	2%	2%	3%	2%	2%	3%
Turn Type		Perm			pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8			6	
Actuated Green, G (s)	13.8	13.8	64.4		96.2	96.2
Effective Green, g (s)	13.8	13.8	64.4		96.2	96.2
Actuated g/C Ratio	0.12	0.12	0.54		0.80	0.80
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	204	182	1814		624	2810
v/s Ratio Prot	c0.07		0.29		c0.17	0.12
v/s Ratio Perm		0.02			c0.45	
v/c Ratio	0.62	0.21	0.54		0.78	0.15
Uniform Delay, d1	50.6	48.2	18.1		18.5	2.7
Progression Factor	1.00	1.00	1.00		0.70	0.81
Incremental Delay, d2	5.5	0.6	1.2		5.2	0.1
Delay (s)	56.1	48.8	19.3		18.2	2.3
Level of Service	E	D	B		B	A
Approach Delay (s)	50.7		19.3			10.7
Approach LOS	D		B			B

Intersection Summary			
HCM Average Control Delay	22.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	71.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
11: Waverly Road & US 56 — AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰	↑↑	↱	↰↰	↑↱		↰	↑↑	↱	↰	↑↑	↱
Volume (vph)	0	110	10	560	110	50	80	190	0	10	90	360
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor		0.95	1.00	0.97	0.95		1.00	0.95		1.00	0.95	1.00
Frt		1.00	0.85	1.00	0.95		1.00	1.00		1.00	1.00	0.85
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)		3539	1615	3400	3312		1736	3406		1805	3059	1568
Flt Permitted		1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)		3539	1615	3400	3312		1736	3406		1805	3059	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	116	11	589	116	53	84	200	0	11	95	379
RTOR Reduction (vph)	0	0	10	0	33	0	0	0	0	0	0	242
Lane Group Flow (vph)	0	116	1	589	136	0	84	200	0	11	95	137
Heavy Vehicles (%)	0%	2%	0%	3%	2%	8%	4%	6%	0%	0%	18%	3%
Turn Type	Prot		Perm	Prot			Prot		Perm	Prot		Perm
Protected Phases	3	8		7	4		5	2		1	6	
Permitted Phases			8					2	2			6
Actuated Green, G (s)		8.3	8.3	20.7	34.0		8.5	39.5		1.5	32.5	32.5
Effective Green, g (s)		8.3	8.3	20.7	34.0		8.5	39.5		1.5	32.5	32.5
Actuated g/C Ratio		0.09	0.09	0.23	0.38		0.09	0.44		0.02	0.36	0.36
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)		326	149	782	1251		164	1495		30	1105	566
v/s Ratio Prot		c0.03		c0.17	0.04		c0.05	0.06		0.01	0.03	
v/s Ratio Perm			0.00									c0.09
v/c Ratio		0.36	0.01	0.75	0.11		0.51	0.13		0.37	0.09	0.24
Uniform Delay, d1		38.3	37.1	32.3	18.2		38.8	15.1		43.8	19.0	20.1
Progression Factor		1.01	1.03	0.94	0.84		0.90	0.74		1.32	0.56	0.99
Incremental Delay, d2		0.7	0.0	3.7	0.0		2.6	0.2		6.5	0.1	0.9
Delay (s)		39.6	38.2	34.1	15.3		37.4	11.4		64.3	10.8	20.8
Level of Service		D	D	C	B		D	B		E	B	C
Approach Delay (s)		39.4			29.9			19.1			19.8	
Approach LOS		D			C			B			B	

Intersection Summary			
HCM Average Control Delay	25.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	42.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
12: 183rd Street & Four Corners Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✥			✥			✥			✥	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	20	20	5	40	5	40	100	5	10	160	5
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	21	21	5	42	5	42	105	5	11	168	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	47	53	153	184
Volume Left (vph)	5	5	42	11
Volume Right (vph)	21	5	5	5
Hadj (s)	-0.24	0.00	0.07	0.03
Departure Headway (s)	4.5	4.7	4.4	4.3
Degree Utilization, x	0.06	0.07	0.19	0.22
Capacity (veh/h)	733	700	786	798
Control Delay (s)	7.8	8.1	8.4	8.6
Approach Delay (s)	7.8	8.1	8.4	8.6
Approach LOS	A	A	A	A

Intersection Summary			
Delay	8.4		
HCM Level of Service	A		
Intersection Capacity Utilization	30.5%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

13: 183rd Street & US 56

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	20	20	5	20	20	5	0	250	20	5	110	30
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	21	5	21	21	5	0	263	21	5	116	32
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	432	426	132	432	432	274	147			284		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	432	426	132	432	432	274	147			284		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	96	96	99	96	96	99	100			100		
cM capacity (veh/h)	516	521	923	517	518	770	1447			1290		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	47	47	284	153
Volume Left	21	21	0	5
Volume Right	5	5	21	32
cSH	545	537	1447	1290
Volume to Capacity	0.09	0.09	0.00	0.00
Queue Length 95th (ft)	7	7	0	0
Control Delay (s)	12.2	12.4	0.0	0.3
Lane LOS	B	B		A
Approach Delay (s)	12.2	12.4	0.0	0.3
Approach LOS	B	B		

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	24.4%	ICU Level of Service	A
Analysis Period (min)	15		

14: 183rd Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	20	20	5	20	20	10	5	200	20	10	170	30
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	21	5	21	21	11	5	211	21	11	179	32
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	32			26			255	139	24	261	137	26
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	32			26			255	139	24	261	137	26
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			99			99	71	98	98	76	97
cM capacity (veh/h)	1594			1601			542	732	1059	521	734	1047

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	47	53	237	221
Volume Left	21	21	5	11
Volume Right	5	11	21	32
cSH	1594	1601	747	752
Volume to Capacity	0.01	0.01	0.32	0.29
Queue Length 95th (ft)	1	1	34	31
Control Delay (s)	3.3	3.0	12.0	11.8
Lane LOS	A	A	B	B
Approach Delay (s)	3.3	3.0	12.0	11.8
Approach LOS			B	B

Intersection Summary			
Average Delay	10.3		
Intersection Capacity Utilization	25.9%	ICU Level of Service	A
Analysis Period (min)	15		

15: 183rd Street & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	120	80	140	240	110	120	90	1120	210	100	960	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.90		1.00	0.92		1.00	0.98		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1679		1770	1717		1770	3427		1770	3485	
Flt Permitted	0.50	1.00		0.24	1.00		0.20	1.00		0.10	1.00	
Satd. Flow (perm)	927	1679		444	1717		365	3427		193	3485	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	126	84	147	253	116	126	95	1179	221	105	1011	116
RTOR Reduction (vph)	0	73	0	0	0	0	0	16	0	0	9	0
Lane Group Flow (vph)	126	158	0	253	242	0	95	1384	0	105	1118	0
Heavy Vehicles (%)	2%	3%	2%	2%	2%	2%	2%	3%	2%	2%	2%	2%
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	18.9	12.9		26.9	16.9		42.7	42.7		43.1	43.1	
Effective Green, g (s)	18.9	12.9		26.9	16.9		42.7	42.7		43.1	43.1	
Actuated g/C Ratio	0.21	0.14		0.30	0.19		0.47	0.47		0.48	0.48	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	251	241		280	322		236	1626		170	1669	
v/s Ratio Prot	0.03	0.09		c0.10	0.14		0.02	c0.40		0.03	c0.32	
v/s Ratio Perm	0.07			c0.17			0.17			0.27		
v/c Ratio	0.50	0.66		0.90	0.75		0.40	0.85		0.62	0.67	
Uniform Delay, d1	30.3	36.5		27.0	34.6		21.8	20.8		19.5	18.0	
Progression Factor	1.00	1.00		1.00	1.00		0.80	0.70		0.70	0.86	
Incremental Delay, d2	1.6	6.3		29.9	9.5		0.8	4.2		4.9	1.6	
Delay (s)	31.7	42.6		57.0	44.1		18.2	18.7		18.5	17.0	
Level of Service	C	D		E	D		B	B		B	B	
Approach Delay (s)		38.8			50.7			18.7			17.2	
Approach LOS		D			D			B			B	

Intersection Summary			
HCM Average Control Delay	24.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	86.0%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

16: Four Corners Road & US 56

AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	110	70	0	140	50	30	190	0	60	80	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	116	74	0	147	53	32	200	0	63	84	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	600	474	200	605	474	84	84			200		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	600	474	200	605	474	84	84			200		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	75	91	100	68	95	98			95		
cM capacity (veh/h)	281	457	843	288	457	975	1506			1372		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	195	200	232	147
Volume Left	5	0	32	63
Volume Right	74	53	0	0
cSH	542	531	1506	1372
Volume to Capacity	0.36	0.38	0.02	0.05
Queue Length 95th (ft)	41	43	2	4
Control Delay (s)	15.3	15.8	1.2	3.5
Lane LOS	C	C	A	A
Approach Delay (s)	15.3	15.8	1.2	3.5
Approach LOS	C	C		

Intersection Summary			
Average Delay	9.0		
Intersection Capacity Utilization	39.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)

17: 191st Street & US 56 — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	20	10	5	5	10	5	0	200	10	0	70	60
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	11	5	5	11	5	0	211	11	0	74	63
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	332	326	105	332	353	216	137			221		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	332	326	105	332	353	216	137			221		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	98	99	99	98	99	100			100		
cM capacity (veh/h)	613	595	955	614	575	829	1460			1360		
Direction, Lane #	**EB 1**	**WB 1**	**NE 1**	**SW 1**								
Volume Total	37	21	221	137								
Volume Left	21	5	0	0								
Volume Right	5	5	11	63								
cSH	640	634	1460	1360								
Volume to Capacity	0.06	0.03	0.00	0.00								
Queue Length 95th (ft)	5	3	0	0								
Control Delay (s)	11.0	10.9	0.0	0.0								
Lane LOS	B	B										
Approach Delay (s)	11.0	10.9	0.0	0.0								
Approach LOS	B	B										
Intersection Summary												
Average Delay			1.5									
Intersection Capacity Utilization			21.8%		ICU Level of Service				A			
Analysis Period (min)			15									

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)

18: 191st Street & Four Corners Road — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	5	15	190	10	105	105
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	16	200	11	111	111
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	537	205			211	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	537	205			211	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	98			92	
cM capacity (veh/h)	467	840			1360	
Direction, Lane #	**WB 1**	**NB 1**	**SB 1**			
Volume Total	21	211	221			
Volume Left	5	0	111			
Volume Right	16	11	0			
cSH	700	1700	1360			
Volume to Capacity	0.03	0.12	0.08			
Queue Length 95th (ft)	2	0	7			
Control Delay (s)	10.3	0.0	4.3			
Lane LOS	B		A			
Approach Delay (s)	10.3	0.0	4.3			
Approach LOS	B					
Intersection Summary						
Average Delay			2.6			
Intersection Capacity Utilization			35.3%	ICU Level of Service		A
Analysis Period (min)			15			

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)

19: 191st Street & Waverly Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	60	5	10	40	10	5	40	30	10	20	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	63	5	11	42	11	5	42	32	11	21	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	53			68			161	150	66	197	147	47
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	53			68			161	150	66	197	147	47
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			99			99	94	97	99	97	99
cM capacity (veh/h)	1566			1546			782	732	995	704	740	1027
Direction, Lane #	**EB 1**	**WB 1**	**NB 1**	**SB 1**								
Volume Total	74	63	79	37								
Volume Left	5	11	5	11								
Volume Right	5	11	32	5								
cSH	1566	1546	823	759								
Volume to Capacity	0.00	0.01	0.10	0.05								
Queue Length 95th (ft)	0	1	8	4								
Control Delay (s)	0.5	1.3	9.8	10.0								
Lane LOS	A	A	A	A								
Approach Delay (s)	0.5	1.3	9.8	10.0								
Approach LOS			A	A								
Intersection Summary												
Average Delay			5.0									
Intersection Capacity Utilization			17.3%		ICU Level of Service				A			
Analysis Period (min)			15									

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)

20: W 188th Street & Gardner Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	30	220	210	30	240	210	970	260	260	1250	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	5.0	5.0	5.0	2.5	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.87		1.00	0.97		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1787	1845	1583	1770	1613		1736	3523		1770	3689	1553
Flt Permitted	0.32	1.00	1.00	0.70	1.00		0.10	1.00		0.10	1.00	1.00
Satd. Flow (perm)	597	1845	1583	1308	1613		191	3523		180	3689	1553
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	74	33	232	228	33	261	221	1021	283	283	1316	105
RTOR Reduction (vph)	0	0	200	0	223	0	0	27	0	0	0	57
Lane Group Flow (vph)	74	33	32	228	71	0	221	1277	0	283	1316	48
Heavy Vehicles (%)	1%	3%	2%	2%	3%	2%	4%	5%	2%	2%	3%	4%
Turn Type	pm+pt		Perm	pm+pt			pm+pt			pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	16.9	12.6	12.6	20.6	13.2		49.3	38.2		55.7	41.4	41.4
Effective Green, g (s)	16.9	12.6	12.6	20.6	13.2		49.3	38.2		55.7	41.4	41.4
Actuated g/C Ratio	0.19	0.14	0.14	0.23	0.15		0.55	0.42		0.62	0.46	0.46
Clearance Time (s)	5.0	5.0	5.0	2.5	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	169	258	222	337	237		295	1495		364	1697	714
v/s Ratio Prot	0.02	0.02		c0.06	0.04		0.09	c0.36		c0.12	0.36	
v/s Ratio Perm	0.06		0.02	c0.10			0.32			0.36		0.03
v/c Ratio	0.44	0.13	0.15	0.68	0.30		0.75	0.85		0.78	0.78	0.07
Uniform Delay, d1	31.4	33.9	34.0	31.0	34.3		18.4	23.4		22.7	20.4	13.5
Progression Factor	0.99	0.99	0.95	1.00	1.00		1.00	0.87		1.33	0.58	0.46
Incremental Delay, d2	1.8	0.2	0.3	5.3	0.7		8.9	5.7		8.4	1.9	0.0
Delay (s)	32.9	33.7	32.6	36.3	35.0		27.4	26.1		38.6	13.6	6.2
Level of Service	C	C	C	D	C		C	C		D	B	A
Approach Delay (s)		32.8			35.6			26.3			17.3	
Approach LOS		C			D			C			B	
Intersection Summary												
HCM Average Control Delay			24.3		HCM Level of Service				C			
HCM Volume to Capacity ratio			0.82									
Actuated Cycle Length (s)			90.0		Sum of lost time (s)				20.0			
Intersection Capacity Utilization			85.0%		ICU Level of Service				E			
Analysis Period (min)			15									

c Critical Lane Group

2030 Gardner No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)

21: I-35 SB Ramps & Gardner Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	210	0	620	10	820	0	0	1510	170
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)				5.0	5.0	2.5	2.5	5.0			5.0	
Lane Util. Factor				1.00	0.95	0.95	1.00	0.95			0.95	
Frt				1.00	0.85	0.85	1.00	1.00			0.98	
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1703	1421	1421	1805	3689			3662	
Flt Permitted				0.95	1.00	1.00	0.09	1.00			1.00	
Satd. Flow (perm)				1703	1421	1421	173	3689			3662	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	221	0	653	11	863	0	0	1589	179
RTOR Reduction (vph)	0	0	0	0	230	66	0	0	0	0	8	0
Lane Group Flow (vph)	0	0	0	221	97	260	11	863	0	0	1760	0
Heavy Vehicles (%)	0%	0%	0%	6%	0%	8%	0%	3%	0%	0%	2%	4%
Turn Type				custom		custom	pm+pt					
Protected Phases				8	8	1	5	2			6	
Permitted Phases				8		8	2					
Actuated Green, G (s)				16.2	16.2	33.6	45.0	43.9			60.2	
Effective Green, g (s)				16.2	16.2	33.6	45.0	43.9			60.2	
Actuated g/C Ratio				0.18	0.18	0.37	0.50	0.49			0.67	
Clearance Time (s)				5.0	5.0	2.5	2.5	5.0			5.0	
Vehicle Extension (s)				3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)				307	256	570	106	1799			2449	
v/s Ratio Prot				c0.13	0.07	c0.09	0.00	0.23			c0.48	
v/s Ratio Perm						0.09	0.05					
v/c Ratio				0.72	0.38	0.46	0.10	0.48			0.72	
Uniform Delay, d1				34.8	32.5	21.3	29.4	15.4			9.5	
Progression Factor				1.00	1.00	1.00	0.62	0.51			0.55	
Incremental Delay, d2				7.9	0.9	0.6	0.1	0.2			1.3	
Delay (s)				42.6	33.4	21.9	18.3	8.1			6.5	
Level of Service				D	C	C	B	A			A	
Approach Delay (s)		0.0			31.4			8.2			6.5	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM Average Control Delay	13.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	94.7%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)

22: I-35 NB Ramps & Gardner Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	380	0	40	0	0	0	0	450	460	1060	660	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0						5.0	5.0	5.0	5.0	
Lane Util. Factor		1.00						1.00	1.00	0.97	0.95	
Frt		0.99						1.00	0.85	1.00	1.00	
Flt Protected		0.96						1.00	1.00	0.95	1.00	
Satd. Flow (prot)		1754						1923	1583	3433	3725	
Flt Permitted		0.96						1.00	1.00	0.95	1.00	
Satd. Flow (perm)		1754						1923	1583	3433	3725	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	400	0	42	0	0	0	0	474	484	1116	695	0
RTOR Reduction (vph)	0	5	0	0	0	0	0	0	348	0	0	0
Lane Group Flow (vph)	0	437	0	0	0	0	0	474	136	1116	695	0
Heavy Vehicles (%)	2%	0%	5%	0%	0%	0%	0%	4%	2%	2%	2%	0%
Turn Type	Split								Perm	Prot		
Protected Phases	4	4						2		1	6	
Permitted Phases									2			
Actuated Green, G (s)		22.0						23.0	23.0	30.0	58.0	
Effective Green, g (s)		22.0						23.0	23.0	30.0	58.0	
Actuated g/C Ratio		0.24						0.26	0.26	0.33	0.64	
Clearance Time (s)		5.0						5.0	5.0	5.0	5.0	
Vehicle Extension (s)		3.0						3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)		429						491	405	1144	2401	
v/s Ratio Prot		c0.25						c0.25		c0.33	0.19	
v/s Ratio Perm									0.09			
v/c Ratio		1.02						0.97	0.33	0.98	0.29	
Uniform Delay, d1		34.0						33.1	27.3	29.6	7.0	
Progression Factor		1.00						0.89	1.08	0.80	0.63	
Incremental Delay, d2		48.5						29.6	1.9	16.9	0.2	
Delay (s)		82.5						59.0	31.3	40.6	4.6	
Level of Service		F						E	C	D	A	
Approach Delay (s)		82.5			0.0			45.0			26.8	
Approach LOS		F			A			D			C	

Intersection Summary			
HCM Average Control Delay	39.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	94.7%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)

23: E 191st Street & Gardner Rd

AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	20	80	830	20	100	600
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		5.0			5.0
Lane Util. Factor	1.00		1.00			1.00
Frt	0.89		1.00			1.00
Flt Protected	0.99		1.00			0.99
Satd. Flow (prot)	1639		1840			1842
Flt Permitted	0.99		1.00			0.77
Satd. Flow (perm)	1639		1840			1431
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	84	874	21	105	632
RTOR Reduction (vph)	78	0	1	0	0	0
Lane Group Flow (vph)	27	0	894	0	0	737
Heavy Vehicles (%)	0%	3%	3%	0%	5%	2%
Turn Type					Perm	
Protected Phases	8		2			6
Permitted Phases					6	
Actuated Green, G (s)	6.4		73.6			73.6
Effective Green, g (s)	6.4		73.6			73.6
Actuated g/C Ratio	0.07		0.82			0.82
Clearance Time (s)	5.0		5.0			5.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	117		1505			1170
v/s Ratio Prot	c0.02		0.49			
v/s Ratio Perm						c0.51
v/c Ratio	0.23		0.59			0.63
Uniform Delay, d1	39.5		2.9			3.1
Progression Factor	1.00		0.51			1.36
Incremental Delay, d2	1.0		0.6			2.5
Delay (s)	40.5		2.1			6.7
Level of Service	D		A			A
Approach Delay (s)	40.5		2.1			6.7
Approach LOS	D		A			A

Intersection Summary			
HCM Average Control Delay	6.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	100.5%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)

24: Sunflower Road & US 56

AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	5	20	5	270	30	5	5	200	360	10	60	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.98			1.00			0.91			1.00	
Flt Protected		0.99			0.96			1.00			0.99	
Satd. Flow (prot)		1844			1779			1669			1635	
Flt Permitted		0.95			0.73			1.00			0.92	
Satd. Flow (perm)		1762			1353			1667			1523	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	5	21	5	284	32	5	5	211	379	11	63	0
RTOR Reduction (vph)	0	4	0	0	1	0	0	59	0	0	0	0
Lane Group Flow (vph)	0	27	0	0	320	0	0	536	0	0	74	0
Heavy Vehicles (%)	0%	0%	0%	2%	3%	0%	0%	6%	3%	0%	18%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		26.0			26.0			54.0			54.0	
Effective Green, g (s)		26.0			26.0			54.0			54.0	
Actuated g/C Ratio		0.29			0.29			0.60			0.60	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		509			391			1000			914	
v/s Ratio Prot												
v/s Ratio Perm		0.02			c0.24			c0.32			0.05	
v/c Ratio		0.05			0.82			0.54			0.08	
Uniform Delay, d1		23.1			29.8			10.6			7.6	
Progression Factor		1.00			0.99			0.64			1.18	
Incremental Delay, d2		0.0			10.5			1.8			0.2	
Delay (s)		23.2			40.1			8.6			9.1	
Level of Service		C			D			A			A	
Approach Delay (s)		23.2			40.1			8.6			9.1	
Approach LOS		C			D			A			A	

Intersection Summary			
HCM Average Control Delay	19.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	65.3%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
25: US 56 & 4th Street — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	480	130	80	250	110	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0			5.0	5.0	
Lane Util. Factor	1.00			1.00	1.00	
Frt	0.97			1.00	0.94	
Flt Protected	1.00			0.99	0.97	
Satd. Flow (prot)	1778			1779	1672	
Flt Permitted	1.00			0.77	0.97	
Satd. Flow (perm)	1778			1379	1672	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	505	137	84	263	116	84
RTOR Reduction (vph)	8	0	0	0	33	0
Lane Group Flow (vph)	634	0	0	347	167	0
Heavy Vehicles (%)	4%	3%	4%	6%	5%	3%
Turn Type			Perm			
Protected Phases	4			8	2	
Permitted Phases			8			
Actuated Green, G (s)	65.9			65.9	14.1	
Effective Green, g (s)	65.9			65.9	14.1	
Actuated g/C Ratio	0.73			0.73	0.16	
Clearance Time (s)	5.0			5.0	5.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	1302			1010	262	
v/s Ratio Prot	c0.36				c0.10	
v/s Ratio Perm				0.25		
v/c Ratio	0.49			0.34	0.64	
Uniform Delay, d1	5.0			4.3	35.6	
Progression Factor	1.00			0.37	1.00	
Incremental Delay, d2	1.3			0.8	5.0	
Delay (s)	6.3			2.4	40.6	
Level of Service	A			A	D	
Approach Delay (s)	6.3			2.4	40.6	
Approach LOS	A			A	D	

Intersection Summary			
HCM Average Control Delay	10.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	74.2%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
26: 199th Street & Four Corners Road — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	390	320	100	100	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	11	411	337	105	105	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	442				821	389
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	442				821	389
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				69	99
cM capacity (veh/h)	1129				341	663

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	421	442	111
Volume Left	11	0	105
Volume Right	0	105	5
cSH	1129	1700	349
Volume to Capacity	0.01	0.26	0.32
Queue Length 95th (ft)	1	0	33
Control Delay (s)	0.3	0.0	20.0
Lane LOS	A		C
Approach Delay (s)	0.3	0.0	20.0
Approach LOS			C

Intersection Summary			
Average Delay	2.4		
Intersection Capacity Utilization	41.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
27: 199th Street & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	210	10	30	170	430	10	260	20	260	90	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00		1.00		1.00	1.00	1.00
Frt	1.00	0.99		1.00	1.00	0.85		0.99		1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		1.00		0.95	1.00	1.00
Satd. Flow (prot)	1752	1834		1752	1863	1583		1830		1770	1863	1583
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.99		0.45	1.00	1.00
Satd. Flow (perm)	1752	1834		1752	1863	1583		1818		830	1863	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	32	221	11	32	179	453	11	274	21	274	95	53
RTOR Reduction (vph)	0	2	0	0	0	368	0	2	0	0	0	21
Lane Group Flow (vph)	32	230	0	32	179	85	0	304	0	274	95	32
Heavy Vehicles (%)	3%	3%	0%	3%	2%	2%	0%	3%	0%	2%	2%	2%
Turn Type	Prot			Prot		Perm	Perm			pm+pt		Perm
Protected Phases	5	2		1	6			8		7	4	
Permitted Phases						6	8			4		4
Actuated Green, G (s)	4.2	16.4		4.6	16.8	16.8		37.1		54.0	54.0	54.0
Effective Green, g (s)	4.2	16.4		4.6	16.8	16.8		37.1		54.0	54.0	54.0
Actuated g/C Ratio	0.05	0.18		0.05	0.19	0.19		0.41		0.60	0.60	0.60
Clearance Time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	82	334		90	348	295		749		622	1118	950
v/s Ratio Prot	0.02	c0.13		0.02	c0.10					c0.06	0.05	
v/s Ratio Perm						0.05		0.17		c0.21		0.02
v/c Ratio	0.39	0.69		0.36	0.51	0.29		0.41		0.44	0.08	0.03
Uniform Delay, d1	41.7	34.4		41.3	32.9	31.5		18.7		9.8	7.6	7.3
Progression Factor	0.90	0.89		1.00	1.00	1.00		1.00		1.66	1.57	2.66
Incremental Delay, d2	3.0	5.8		2.4	1.3	0.5		1.6		0.4	0.1	0.1
Delay (s)	40.4	36.4		43.7	34.2	32.0		20.3		16.6	12.0	19.6
Level of Service	D	D		D	C	C		C		B	B	B
Approach Delay (s)		36.9			33.2			20.3			16.0	
Approach LOS		D			C			C			B	

Intersection Summary			
HCM Average Control Delay	27.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	61.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
30: US-56 & I-35 NB Loop — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	1310	1670	0	1760	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	1379	1758	0	1853	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked					0.61	
vC, conflicting volume			3137		2305	689
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			3137		1855	689
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			103		41	393

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	689	689	1758	926	926
Volume Left	0	0	0	0	0
Volume Right	0	0	1758	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.41	0.41	1.03	0.54	0.54
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	106.7%	ICU Level of Service	G
Analysis Period (min)	15		

2030 Gardner No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
37: 199th Street & West Waverley — AM Peak Hour

Movement	EBL	EBT	WBU	WBT	WBR	SBL	SBR
Lane Configurations							
Volume (veh/h)	10	730	0	670	60	30	10
Sign Control		Free		Free		Stop	
Grade		0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	793	0	728	65	33	11
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type		TWLTL		TWLTL			
Median storage veh)		2		2			
Upstream signal (ft)				802			
pX, platoon unblocked			0.00				
vC, conflicting volume	793		0			1576	761
vC1, stage 1 conf vol						761	
vC2, stage 2 conf vol						815	
vCu, unblocked vol	793		0			1576	761
tC, single (s)	4.1		0.0			6.4	6.2
tC, 2 stage (s)						5.4	
tF (s)	2.2		0.0			3.5	3.3
p0 queue free %	99		0			90	97
cM capacity (veh/h)	836		0			331	404

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	11	793	793	0	43
Volume Left	11	0	0	0	33
Volume Right	0	0	65	0	11
cSH	836	1700	1700	1700	346
Volume to Capacity	0.01	0.47	0.47	0.00	0.13
Queue Length 95th (ft)	1	0	0	0	11
Control Delay (s)	9.4	0.0	0.0	0.0	16.9
Lane LOS	A				C
Approach Delay (s)	0.1		0.0		16.9
Approach LOS					C

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	48.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
38: 199th Street & IH-35 SB Ramp — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	700	60	50	280	0	0	0	0	10	0	460
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		2.5		2.5	2.5					2.5		2.5
Lane Util. Factor		1.00		1.00	1.00					1.00		1.00
Frt		0.99		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		1843		1770	1863					1805		1583
Flt Permitted		1.00		0.27	1.00					0.95		1.00
Satd. Flow (perm)		1843		509	1863					1805		1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	761	65	54	304	0	0	0	0	11	0	500
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	459
Lane Group Flow (vph)	0	824	0	54	304	0	0	0	0	11	0	41
Heavy Vehicles (%)	0%	2%	2%	2%	2%	0%	0%	0%	0%	0%	0%	2%
Turn Type				pm+pt						Prot		custom
Protected Phases		4		3	8					1		
Permitted Phases				8								1
Actuated Green, G (s)		70.3		77.6	77.6					7.4		7.4
Effective Green, g (s)		70.3		77.6	77.6					7.4		7.4
Actuated g/C Ratio		0.78		0.86	0.86					0.08		0.08
Clearance Time (s)		2.5		2.5	2.5					2.5		2.5
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		1440		506	1606					148		130
v/s Ratio Prot		c0.45		0.01	c0.16					0.01		
v/s Ratio Perm				0.09								c0.03
v/c Ratio		0.57		0.11	0.19					0.07		0.32
Uniform Delay, d1		3.9		2.6	1.0					38.1		38.9
Progression Factor		1.80		0.29	0.63					1.00		1.00
Incremental Delay, d2		1.6		0.1	0.1					0.2		1.4
Delay (s)		8.6		0.8	0.7					38.4		40.3
Level of Service		A		A	A					D		D
Approach Delay (s)		8.6			0.7			0.0			40.3	
Approach LOS		A			A			A			D	

Intersection Summary			
HCM Average Control Delay	16.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	7.5
Intersection Capacity Utilization	63.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
39: 199th Street & IH-35 NB Ramp — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	580	130	0	0	160	20	170	0	90	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0		5.0			
Lane Util. Factor	1.00	1.00			1.00		1.00		1.00			
Frt	1.00	1.00			0.98		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1770	1863			1839		1770		1583			
Flt Permitted	0.56	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	1046	1863			1839		1770		1583			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	630	141	0	0	174	22	185	0	98	0	0	0
RTOR Reduction (vph)	0	0	0	0	5	0	0	0	83	0	0	0
Lane Group Flow (vph)	630	141	0	0	191	0	185	0	15	0	0	0
Heavy Vehicles (%)	2%	2%	0%	0%	2%	0%	2%	0%	2%	0%	0%	0%
Turn Type	pm+pt						custom		custom			
Protected Phases	7	4			8							
Permitted Phases	4						2		2			
Actuated Green, G (s)	66.0	66.0			22.9		14.0		14.0			
Effective Green, g (s)	66.0	66.0			22.9		14.0		14.0			
Actuated g/C Ratio	0.73	0.73			0.25		0.16		0.16			
Clearance Time (s)	5.0	5.0			5.0		5.0		5.0			
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Lane Grp Cap (vph)	1074	1366			468		275		246			
v/s Ratio Prot	c0.25	0.08			0.10							
v/s Ratio Perm	c0.18						c0.10		0.01			
v/c Ratio	0.59	0.10			0.41		0.67		0.06			
Uniform Delay, d1	8.1	3.5			27.9		35.8		32.4			
Progression Factor	0.61	0.52			0.48		1.00		1.00			
Incremental Delay, d2	0.7	0.1			0.6		6.3		0.1			
Delay (s)	5.6	1.9			13.9		42.2		32.5			
Level of Service	A	A			B		D		C			
Approach Delay (s)		4.9			13.9			38.8			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	14.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	63.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
40: 199th Street & East Waverley — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	200	10	5	160	10	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	217	11	5	174	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	820					
pX, platoon unblocked						
vC, conflicting volume			228		408	223
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			228		408	223
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	99
cM capacity (veh/h)			1352		601	822

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	228	179	16
Volume Left	0	5	11
Volume Right	11	0	5
cSH	1700	1352	660
Volume to Capacity	0.13	0.00	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.3	10.6
Lane LOS		A	B
Approach Delay (s)	0.0	0.3	10.6
Approach LOS			B

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	22.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action

1: 175th Street & Waverly Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	10	330	10	20	30	630	210	10	10	130	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.91		1.00	0.99		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1677		1805	1819		1770	3517		1805	3407	
Flt Permitted	0.72	1.00		0.41	1.00		0.57	1.00		0.61	1.00	
Satd. Flow (perm)	1346	1677		784	1819		1071	3517		1154	3407	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	53	11	347	11	21	32	663	221	11	11	137	42
RTOR Reduction (vph)	0	310	0	0	29	0	0	3	0	0	20	0
Lane Group Flow (vph)	53	48	0	11	24	0	663	229	0	11	159	0
Heavy Vehicles (%)	2%	0%	2%	0%	0%	0%	2%	2%	0%	0%	2%	3%
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	9.7	9.7		9.7	9.7		70.3	64.5		45.7	44.9	
Effective Green, g (s)	9.7	9.7		9.7	9.7		70.3	64.5		45.7	44.9	
Actuated g/C Ratio	0.11	0.11		0.11	0.11		0.78	0.72		0.51	0.50	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	145	181		84	196		995	2521		592	1700	
v/s Ratio Prot		0.03			0.01		c0.15	0.07		0.00	0.05	
v/s Ratio Perm	c0.04			0.01			c0.37			0.01		
v/c Ratio	0.37	0.27		0.13	0.12		0.67	0.09		0.02	0.09	
Uniform Delay, d1	37.3	36.9		36.3	36.3		3.8	3.9		11.0	11.9	
Progression Factor	1.00	1.00		1.00	1.00		0.93	0.58		1.00	1.00	
Incremental Delay, d2	1.6	0.8		0.7	0.3		1.5	0.1		0.0	0.1	
Delay (s)	38.9	37.7		37.0	36.6		5.0	2.3		11.0	12.0	
Level of Service	D	D		D	D		A	A		B	B	
Approach Delay (s)		37.8			36.7			4.3			11.9	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM Average Control Delay	15.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	72.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action

2: US 56 & Gardner Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	130	440	60	300	890	440	50	890	220	320	930	120
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3551	1583	1770	3689	1583	1770	3725	1568	3400	3479	
Flt Permitted	0.17	1.00	1.00	0.35	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	317	3551	1583	661	3689	1583	1770	3725	1568	3400	3479	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	463	63	316	937	463	53	937	232	337	979	126
RTOR Reduction (vph)	0	0	47	0	0	249	0	0	162	0	11	0
Lane Group Flow (vph)	137	463	16	316	937	214	53	937	70	337	1094	0
Heavy Vehicles (%)	2%	7%	2%	2%	3%	2%	2%	2%	3%	3%	2%	2%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			
Actuated Green, G (s)	29.3	23.5	23.5	37.3	29.0	29.0	4.4	27.2	27.2	11.3	34.1	
Effective Green, g (s)	29.3	23.5	23.5	37.3	29.0	29.0	4.4	27.2	27.2	11.3	34.1	
Actuated g/C Ratio	0.33	0.26	0.26	0.41	0.32	0.32	0.05	0.30	0.30	0.13	0.38	
Clearance Time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	197	927	413	413	1189	510	87	1126	474	427	1318	
v/s Ratio Prot	0.04	0.13		c0.10	c0.25		0.03	c0.25		0.10	c0.31	
v/s Ratio Perm	0.18		0.01	0.22		0.13			0.04			
v/c Ratio	0.70	0.50	0.04	0.77	0.79	0.42	0.61	0.83	0.15	0.79	0.83	
Uniform Delay, d1	23.1	28.3	24.8	19.3	27.7	23.9	42.0	29.3	22.9	38.2	25.3	
Progression Factor	1.18	0.71	0.67	0.67	0.80	0.60	0.86	0.75	1.89	1.00	1.00	
Incremental Delay, d2	9.9	1.9	0.2	5.9	3.8	1.8	6.8	3.2	0.1	9.4	4.5	
Delay (s)	37.3	21.9	16.8	18.8	26.0	16.0	42.7	25.2	43.4	47.6	29.8	
Level of Service	D	C	B	B	C	B	D	C	D	D	C	
Approach Delay (s)		24.6			22.0			29.4			34.0	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	27.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	14.1
Intersection Capacity Utilization	79.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action

3: US 56 & Elm

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	970	30	40	1630	40	20	10	50	100	20	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			1.00		1.00	0.88		1.00	0.91	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3424			3521		1719	1637		1770	1697	
Flt Permitted		0.93			0.90		0.72	1.00		0.72	1.00	
Satd. Flow (perm)		3173			3162		1307	1637		1332	1697	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	11	1021	32	42	1716	42	21	11	53	105	21	32
RTOR Reduction (vph)	0	2	0	0	1	0	0	47	0	0	25	0
Lane Group Flow (vph)	0	1062	0	0	1799	0	21	17	0	105	28	0
Heavy Vehicles (%)	0%	5%	3%	3%	2%	3%	5%	0%	2%	2%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		70.0			70.0		11.0	11.0		11.0	11.0	
Effective Green, g (s)		70.0			70.0		11.0	11.0		11.0	11.0	
Actuated g/C Ratio		0.78			0.78		0.12	0.12		0.12	0.12	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2468			2459		160	200		163	207	
v/s Ratio Prot								0.01			0.02	
v/s Ratio Perm		0.33			c0.57		0.02			c0.08		
v/c Ratio		0.43			0.73		0.13	0.09		0.64	0.14	
Uniform Delay, d1		3.3			5.2		35.2	35.0		37.6	35.3	
Progression Factor		1.88			0.65		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.5			1.4		0.4	0.2		8.4	0.3	
Delay (s)		6.8			4.8		35.6	35.2		46.1	35.6	
Level of Service		A			A		D	D		D	D	
Approach Delay (s)		6.8			4.8			35.3			42.5	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	8.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	94.8%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action

4: US 56 & Mulberry

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	1100	10	30	1740	40	10	5	20	40	10	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			1.00		1.00	0.88		1.00	0.90	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3467			3523		1805	1605		1752	1713	
Flt Permitted		0.88			0.91		0.74	1.00		0.74	1.00	
Satd. Flow (perm)		3069			3215		1399	1605		1366	1713	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	1158	11	32	1832	42	11	5	21	42	11	21
RTOR Reduction (vph)	0	1	0	0	2	0	0	20	0	0	20	0
Lane Group Flow (vph)	0	1189	0	0	1904	0	11	6	0	42	12	0
Heavy Vehicles (%)	0%	4%	0%	3%	2%	3%	0%	0%	5%	3%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		75.5			75.5		5.5	5.5		5.5	5.5	
Effective Green, g (s)		75.5			75.5		5.5	5.5		5.5	5.5	
Actuated g/C Ratio		0.84			0.84		0.06	0.06		0.06	0.06	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2575			2697		85	98		83	105	
v/s Ratio Prot								0.00			0.01	
v/s Ratio Perm		0.39			c0.59		0.01			c0.03		
v/c Ratio		0.46			0.71		0.13	0.06		0.51	0.12	
Uniform Delay, d1		1.9			2.9		40.0	39.8		40.9	40.0	
Progression Factor		0.18			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.6			1.6		0.7	0.3		4.8	0.5	
Delay (s)		0.9			4.4		40.7	40.1		45.7	40.5	
Level of Service		A			A		D	D		D	D	
Approach Delay (s)		0.9			4.4			40.3			43.4	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	4.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	87.1%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner No Action - PM Peak Hour - Synchro Intersection LOS

5: US 56 & Moonlight Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	150	760	250	370	1530	1280	200	550	160	730	730	170
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1752	3619	1583	1770	3725	1583	1770	3725	1583	3433	3539	1583
Flt Permitted	0.10	1.00	1.00	0.17	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	181	3619	1583	325	3725	1583	1770	3725	1583	3433	3539	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	158	800	263	389	1611	1347	211	579	168	768	768	179
RTOR Reduction (vph)	0	0	126	0	0	315	0	0	116	0	0	84
Lane Group Flow (vph)	158	800	137	389	1611	1032	211	579	52	768	768	95
Heavy Vehicles (%)	3%	5%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		custom	Prot		Perm
Protected Phases	5	2		1	6		3	8	8	7	4	
Permitted Phases	2		2	6		6			8			4
Actuated Green, G (s)	46.3	40.8	40.8	67.5	56.5	56.5	11.5	15.5	15.5	19.5	23.5	23.5
Effective Green, g (s)	46.3	40.8	40.8	67.5	56.5	56.5	11.5	15.5	15.5	19.5	23.5	23.5
Actuated g/C Ratio	0.39	0.34	0.34	0.56	0.47	0.47	0.10	0.13	0.13	0.16	0.20	0.20
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	142	1230	538	438	1754	745	170	481	204	558	693	310
v/s Ratio Prot	0.05	0.22		c0.16	0.43		0.12	c0.16	0.03	c0.22	0.22	
v/s Ratio Perm	0.38		0.09	0.34		c0.65						0.06
v/c Ratio	1.11	0.65	0.25	0.89	0.92	1.39	1.24	1.20	0.26	1.38	1.11	0.31
Uniform Delay, d1	34.0	33.6	28.6	24.3	29.6	31.8	54.2	52.2	47.1	50.2	48.2	41.3
Progression Factor	1.00	1.00	1.00	1.51	0.88	0.73	1.04	1.04	1.24	1.00	1.00	1.00
Incremental Delay, d2	109.0	2.7	1.1	2.2	1.0	174.2	144.5	108.1	0.2	180.4	67.8	0.2
Delay (s)	142.9	36.2	29.8	38.9	27.0	197.3	201.0	162.6	58.6	230.7	116.1	41.5
Level of Service	F	D	C	D	C	F	F	F	E	F	F	D
Approach Delay (s)		48.6			96.9			152.8			159.6	
Approach LOS		D			F			F			F	

Intersection Summary			
HCM Average Control Delay	111.0	HCM Level of Service	F
HCM Volume to Capacity ratio	1.35		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	116.6%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action

6: Old US 56 & US 56

PM Peak Hour

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	730	20	1360	290	10	2440
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1538	3654	1568	1805	3725
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1538	3654	1568	1805	3725
Peak-hour factor, PHF	0.97	0.97	0.95	0.95	0.95	0.95
Adj. Flow (vph)	753	21	1432	305	11	2568
RTOR Reduction (vph)	0	9	0	40	0	0
Lane Group Flow (vph)	753	12	1432	265	11	2568
Heavy Vehicles (%)	2%	5%	4%	3%	0%	2%
Turn Type		Perm		pm+ov	Prot	
Protected Phases	8		2	8	1	6
Permitted Phases		8	2	2		6
Actuated Green, G (s)	42.0	42.0	62.2	104.2	0.8	68.0
Effective Green, g (s)	42.0	42.0	62.2	104.2	0.8	68.0
Actuated g/C Ratio	0.35	0.35	0.52	0.87	0.01	0.57
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	620	538	1894	1427	12	2111
v/s Ratio Prot	c0.43		0.39	0.06	0.01	c0.69
v/s Ratio Perm		0.01		0.10		
v/c Ratio	1.21	0.02	0.76	0.19	0.92	1.22
Uniform Delay, d1	39.0	25.5	22.9	1.2	59.6	26.0
Progression Factor	1.00	1.00	1.58	3.62	0.82	0.58
Incremental Delay, d2	110.8	0.0	0.9	0.0	163.9	100.3
Delay (s)	149.8	25.6	37.0	4.5	212.7	115.5
Level of Service	F	C	D	A	F	F
Approach Delay (s)	146.5		31.3			115.9
Approach LOS	F		C			F

Intersection Summary			
HCM Average Control Delay	91.7	HCM Level of Service	F
HCM Volume to Capacity ratio	1.22		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	112.9%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action

7: US-56 & Cedar Niles

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	60	2120	190	790	1990	60	210	20	850	60	20	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2	5.2	5.2	5.2	5.2
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00	1.00	1.00	0.88	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3689	1583	3433	3689	1583	1770	2000	2787	1770	2000	1568
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.74	1.00	1.00	0.74	1.00	1.00
Satd. Flow (perm)	1770	3689	1583	3433	3689	1583	1385	2000	2787	1385	2000	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	63	2232	200	832	2095	63	221	21	895	63	21	42
RTOR Reduction (vph)	0	0	77	0	0	17	0	0	0	0	0	38
Lane Group Flow (vph)	63	2232	123	832	2095	46	221	21	895	63	21	4
Heavy Vehicles (%)	2%	3%	2%	2%	3%	2%	2%	0%	2%	2%	0%	3%
Turn Type	Prot		Perm	Prot		Perm	Perm		pt+ov	Perm		Perm
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases			2			6	8			4		4
Actuated Green, G (s)	4.8	66.6	66.6	25.0	86.8	86.8	12.8	12.8	43.0	12.8	12.8	12.8
Effective Green, g (s)	4.8	66.6	66.6	25.0	86.8	86.8	12.8	12.8	43.0	12.8	12.8	12.8
Actuated g/C Ratio	0.04	0.55	0.55	0.21	0.72	0.72	0.11	0.11	0.36	0.11	0.11	0.11
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2		5.2	5.2	5.2
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lane Grp Cap (vph)	71	2047	879	715	2668	1145	148	213	999	148	213	167
v/s Ratio Prot	0.04	c0.60		c0.24	0.57			0.01	0.32		0.01	
v/s Ratio Perm			0.08			0.03	c0.16			0.05		0.00
v/c Ratio	0.89	1.09	0.14	1.16	0.79	0.04	1.49	0.10	0.90	0.43	0.10	0.03
Uniform Delay, d1	57.3	26.7	12.9	47.5	10.6	4.7	53.6	48.4	36.4	50.2	48.4	48.0
Progression Factor	0.83	0.70	0.17	1.09	1.04	1.15	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	64.2	48.9	0.3	75.2	0.2	0.0	254.1	0.1	10.2	0.7	0.1	0.0
Delay (s)	112.0	67.5	2.5	127.0	11.2	5.5	307.7	48.5	46.6	50.9	48.5	48.0
Level of Service	F	E	A	F	B	A	F	D	D	D	D	D
Approach Delay (s)		63.4			43.3			97.4			49.5	
Approach LOS		E			D			F			D	

Intersection Summary			
HCM Average Control Delay	60.0	HCM Level of Service	E
HCM Volume to Capacity ratio	1.16		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.6
Intersection Capacity Utilization	109.5%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action

8: US-56 & I-35 SB Ramps

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	2720	280	660	1250	0	0	0	0	170	0	1560
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		0.99		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3486		1752	3725					1770		2787
Flt Permitted		1.00		0.20	1.00					0.95		1.00
Satd. Flow (perm)		3486		363	3725					1770		2787
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2863	295	695	1316	0	0	0	0	179	0	1642
RTOR Reduction (vph)	0	7	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	3151	0	695	1316	0	0	0	0	179	0	1642
Heavy Vehicles (%)	0%	2%	3%	3%	2%	0%	0%	0%	0%	2%	0%	2%
Turn Type				pm+pt						custom		custom
Protected Phases		2		1	6					4		5
Permitted Phases				6						4		4
Actuated Green, G (s)		70.0		45.3	45.3					10.0		59.7
Effective Green, g (s)		70.0		45.3	45.3					10.0		59.7
Actuated g/C Ratio		0.58		0.38	0.38					0.08		0.50
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2034		426	1406					148		1503
v/s Ratio Prot		c0.90		c0.34	0.35					0.10		c0.45
v/s Ratio Perm				c0.28								0.14
v/c Ratio		1.55		1.63	0.94					1.21		1.09
Uniform Delay, d1		25.0		34.6	36.0					55.0		30.2
Progression Factor		0.73		0.96	0.91					1.00		1.00
Incremental Delay, d2		247.4		291.5	8.8					141.2		52.8
Delay (s)		265.7		324.9	41.5					196.2		82.9
Level of Service		F		F	D					F		F
Approach Delay (s)		265.7			139.4			0.0			94.1	
Approach LOS		F			F			A			F	

Intersection Summary			
HCM Average Control Delay	184.6	HCM Level of Service	F
HCM Volume to Capacity ratio	1.44		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	5.0
Intersection Capacity Utilization	141.8%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action

9: US-56 & I-35 NB Ramps

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑			↑↑	↱	↰	↱	↱			
Volume (vph)	0	1530	0	0	1810	580	100	0	390	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95	0.95			
Frt		1.00			1.00	0.85	1.00	0.85	0.85			
Flt Protected		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (prot)		3725			3539	1538	1703	1421	1421			
Flt Permitted		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (perm)		3725			3539	1538	1703	1421	1421			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1611	0	0	1905	611	105	0	411	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	106	0	0	0	0	0	0
Lane Group Flow (vph)	0	1611	0	0	1905	505	105	206	205	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	5%	6%	0%	8%	0%	0%	0%
Turn Type						Perm	Perm		Perm			
Protected Phases		2			6			8				
Permitted Phases						6	8		8			
Actuated Green, G (s)		87.7			87.7	87.7	22.3	22.3	22.3			
Effective Green, g (s)		87.7			87.7	87.7	22.3	22.3	22.3			
Actuated g/C Ratio		0.73			0.73	0.73	0.19	0.19	0.19			
Clearance Time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0	3.0			
Lane Grp Cap (vph)		2722			2586	1124	316	264	264			
v/s Ratio Prot		0.43			c0.54			c0.15				
v/s Ratio Perm						0.33	0.06		0.14			
v/c Ratio		0.59			0.74	0.45	0.33	0.78	0.78			
Uniform Delay, d1		7.7			9.4	6.5	42.4	46.5	46.5			
Progression Factor		0.34			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2		0.1			1.1	0.3	0.6	13.8	13.3			
Delay (s)		2.7			10.5	6.8	43.0	60.4	59.8			
Level of Service		A			B	A	D	E	E			
Approach Delay (s)		2.7			9.6			56.6			0.0	
Approach LOS		A			A			E			A	

Intersection Summary			
HCM Average Control Delay	12.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	86.9%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action

10: Santa Fe & Moonlight Road

PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰	↱	↑↱		↰	↑↑
Volume (vph)	240	480	440	160	380	930
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.96		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3398		1770	3539
Flt Permitted	0.95	1.00	1.00		0.40	1.00
Satd. Flow (perm)	1770	1583	3398		752	3539
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	253	505	463	168	400	979
RTOR Reduction (vph)	0	403	29	0	0	0
Lane Group Flow (vph)	253	102	602	0	400	979
Turn Type		Perm			Perm	
Protected Phases	8		2			6
Permitted Phases		8			6	
Actuated Green, G (s)	20.3	20.3	89.7		89.7	89.7
Effective Green, g (s)	20.3	20.3	89.7		89.7	89.7
Actuated g/C Ratio	0.17	0.17	0.75		0.75	0.75
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	299	268	2540		562	2645
v/s Ratio Prot	c0.14		0.18			0.28
v/s Ratio Perm		0.06			c0.53	
v/c Ratio	0.85	0.38	0.24		0.71	0.37
Uniform Delay, d1	48.3	44.3	4.6		8.2	5.3
Progression Factor	1.00	1.00	1.00		1.91	1.36
Incremental Delay, d2	19.3	0.9	0.2		3.3	0.2
Delay (s)	67.6	45.2	4.9		18.9	7.3
Level of Service	E	D	A		B	A
Approach Delay (s)	52.7		4.9			10.7
Approach LOS	D		A			B

Intersection Summary			
HCM Average Control Delay	20.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action

11: Waverly Road & US 56

PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰	↑↑	↱	↰↰	↑↱		↰	↑↑	↱	↰	↑↑	↱
Volume (vph)	0	150	20	310	110	40	60	130	0	30	190	630
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor		0.95	1.00	0.97	0.95		1.00	0.95		1.00	0.95	1.00
Frt		1.00	0.85	1.00	0.96		1.00	1.00		1.00	1.00	0.85
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)		3539	1615	3400	3372		1770	3282		1752	3438	1583
Flt Permitted		1.00	1.00	0.95	1.00		0.60	1.00		0.67	1.00	1.00
Satd. Flow (perm)		3539	1615	3400	3372		1117	3282		1227	3438	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	158	21	326	116	42	63	137	0	32	200	663
RTOR Reduction (vph)	0	0	19	0	29	0	0	0	0	0	0	362
Lane Group Flow (vph)	0	158	2	326	129	0	63	137	0	32	200	301
Heavy Vehicles (%)	0%	2%	0%	3%	2%	5%	2%	10%	0%	3%	5%	2%
Turn Type	Perm		Perm	Prot			pm+pt		Perm	pm+pt		Perm
Protected Phases		8		7	4		5	2		1	6	
Permitted Phases	8		8				2	2	2	6		6
Actuated Green, G (s)		9.4	9.4	13.8	28.2		48.6	42.7		45.0	40.9	40.9
Effective Green, g (s)		9.4	9.4	13.8	28.2		48.6	42.7		45.0	40.9	40.9
Actuated g/C Ratio		0.10	0.10	0.15	0.31		0.54	0.47		0.50	0.45	0.45
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)		370	169	521	1057		646	1557		637	1562	719
v/s Ratio Prot		c0.04		c0.10	0.04		c0.01	0.04		0.00	0.06	
v/s Ratio Perm			0.00				0.05			0.02		c0.19
v/c Ratio		0.43	0.01	0.63	0.12		0.10	0.09		0.05	0.13	0.42
Uniform Delay, d1		37.8	36.1	35.7	22.1		9.9	13.0		11.5	14.2	16.5
Progression Factor		0.99	0.96	0.92	0.82		1.27	1.24		0.36	0.34	3.09
Incremental Delay, d2		0.8	0.0	2.2	0.0		0.1	0.1		0.0	0.1	1.1
Delay (s)		38.3	34.8	35.1	18.2		12.6	16.2		4.1	5.0	52.3
Level of Service		D	C	D	B		B	B		A	A	D
Approach Delay (s)		37.9			29.6			15.0			40.0	
Approach LOS		D			C			B			D	

Intersection Summary			
HCM Average Control Delay	34.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	59.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action

12: 183rd Street & Four Corners Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✥			✥			✥			✥	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	50	40	0	40	30	10	180	0	5	110	5
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	53	42	0	42	32	11	189	0	5	116	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	100	74	200	126
Volume Left (vph)	5	0	11	5
Volume Right (vph)	42	32	0	5
Hadj (s)	-0.20	-0.21	0.04	0.01
Departure Headway (s)	4.6	4.6	4.5	4.6
Degree Utilization, x	0.13	0.09	0.25	0.16
Capacity (veh/h)	726	719	764	744
Control Delay (s)	8.2	8.1	9.0	8.4
Approach Delay (s)	8.2	8.1	9.0	8.4
Approach LOS	A	A	A	A

Intersection Summary			
Delay	8.6		
HCM Level of Service	A		
Intersection Capacity Utilization	29.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action
13: 183rd Street & US 56 — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✥			✥			✥			✥	
Volume (veh/h)	40	20	5	20	50	5	0	160	30	5	210	20
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	42	21	5	21	53	5	0	168	32	5	221	21
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	458	442	232	442	437	184	242			200		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	458	442	232	442	437	184	242			200		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	91	96	99	96	90	99	100			100		
cM capacity (veh/h)	467	511	813	508	511	863	1336			1384		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	68	79	200	247
Volume Left	42	21	0	5
Volume Right	5	5	32	21
cSH	496	525	1336	1384
Volume to Capacity	0.14	0.15	0.00	0.00
Queue Length 95th (ft)	12	13	0	0
Control Delay (s)	13.4	13.1	0.0	0.2
Lane LOS	B	B		A
Approach Delay (s)	13.4	13.1	0.0	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	3.4		
Intersection Capacity Utilization	30.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action
14: 183rd Street & Waverly Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✥			✥			✥			✥	
Volume (veh/h)	30	20	5	20	50	10	5	180	30	5	210	20
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	32	21	5	21	53	11	5	189	32	5	221	21
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	63			26			318	192	24	313	189	58
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	63			26			318	192	24	313	189	58
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	98			99			99	72	97	99	68	98
cM capacity (veh/h)	1533			1601			457	679	1050	478	682	1014

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	58	84	226	247
Volume Left	32	21	5	5
Volume Right	5	11	32	21
cSH	1533	1601	706	695
Volume to Capacity	0.02	0.01	0.32	0.36
Queue Length 95th (ft)	2	1	35	40
Control Delay (s)	4.1	1.9	12.5	13.0
Lane LOS	A	A	B	B
Approach Delay (s)	4.1	1.9	12.5	13.0
Approach LOS			B	B

Intersection Summary			
Average Delay	10.5		
Intersection Capacity Utilization	27.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action
15: 183rd Street & Gardner Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Volume (vph)	130	120	110	170	120	100	170	980	280	140	950	120
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.93		1.00	0.93		1.00	0.97		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1729		1770	1736		1770	3395		1770	3450	
Flt Permitted	0.36	1.00		0.35	1.00		0.21	1.00		0.12	1.00	
Satd. Flow (perm)	667	1729		647	1736		384	3395		217	3450	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	126	116	179	126	105	179	1032	295	147	1000	126
RTOR Reduction (vph)	0	38	0	0	0	0	0	29	0	0	10	0
Lane Group Flow (vph)	137	204	0	179	231	0	179	1298	0	147	1116	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	3%	2%	2%	3%	2%
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	19.7	14.2		22.9	15.8		41.3	41.3		41.7	41.7	
Effective Green, g (s)	19.7	14.2		22.9	15.8		41.3	41.3		41.7	41.7	
Actuated g/C Ratio	0.22	0.16		0.25	0.18		0.46	0.46		0.46	0.46	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	213	273		253	305		284	1558		228	1599	
v/s Ratio Prot	0.04	0.12		c0.06	c0.13		0.05	c0.38		0.05	c0.32	
v/s Ratio Perm	0.10			0.12			0.24			0.25		
v/c Ratio	0.64	0.75		0.71	0.76		0.63	0.83		0.64	0.70	
Uniform Delay, d1	35.9	36.2		34.5	35.3		25.6	21.3		19.7	19.2	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.49	0.38	
Incremental Delay, d2	6.5	10.6		8.7	10.3		4.5	5.4		3.8	1.6	
Delay (s)	42.6	46.8		43.2	45.5		30.1	26.7		33.2	8.8	
Level of Service	D	D		D	D		C	C		C	A	
Approach Delay (s)		45.3			44.5			27.1			11.7	
Approach LOS		D			D			C			B	

Intersection Summary			
HCM Average Control Delay	25.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	82.9%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action
16: Four Corners Road & US 56 — PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✥			✥			✥			✥	
Volume (veh/h)	5	130	60	0	120	20	50	130	5	70	160	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	137	63	0	126	21	53	137	5	74	168	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	645	561	139	692	563	168	168			142		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	645	561	139	692	563	168	168			142		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	66	93	100	68	98	96			95		
cM capacity (veh/h)	268	399	909	231	398	881	1409			1447		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	205	147	195	242
Volume Left	5	0	53	74
Volume Right	63	21	5	0
cSH	475	431	1409	1447
Volume to Capacity	0.43	0.34	0.04	0.05
Queue Length 95th (ft)	54	37	3	4
Control Delay (s)	18.2	17.6	2.3	2.6
Lane LOS	C	C	A	A
Approach Delay (s)	18.2	17.6	2.3	2.6
Approach LOS	C	C		

Intersection Summary			
Average Delay	9.4		
Intersection Capacity Utilization	38.5%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner No Action - PM Peak Hour - Synchro Intersection LOS

17: 191st Street & US 56

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	50	10	0	10	10	0	0	120	5	0	160	20
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	53	11	0	11	11	0	0	126	5	0	168	21
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	313	311	179	313	318	129	189			132		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	313	311	179	313	318	129	189			132		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	92	98	100	98	98	100	100			100		
cM capacity (veh/h)	631	607	869	635	601	926	1397			1466		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	63	21	132	189
Volume Left	53	11	0	0
Volume Right	0	0	5	21
cSH	627	618	1397	1466
Volume to Capacity	0.10	0.03	0.00	0.00
Queue Length 95th (ft)	8	3	0	0
Control Delay (s)	11.4	11.0	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	11.4	11.0	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	21.5%	ICU Level of Service	A
Analysis Period (min)	15		

18: 191st Street & Four Corners Road

PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	5	35	195	5	100	100
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	37	205	5	105	105
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	524	208			211	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	524	208			211	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	96			92	
cM capacity (veh/h)	477	830			1360	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	42	211	211
Volume Left	5	0	105
Volume Right	37	5	0
cSH	760	1700	1360
Volume to Capacity	0.06	0.12	0.08
Queue Length 95th (ft)	4	0	6
Control Delay (s)	10.0	0.0	4.3
Lane LOS	B		A
Approach Delay (s)	10.0	0.0	4.3
Approach LOS	B		

Intersection Summary			
Average Delay	2.8		
Intersection Capacity Utilization	34.7%	ICU Level of Service	A
Analysis Period (min)	15		

19: 191st Street & Waverly Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	40	0	30	60	10	5	10	10	10	70	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	42	0	32	63	11	5	11	11	11	74	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	74			42			226	189	42	200	184	68
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	74			42			226	189	42	200	184	68
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			98			99	98	99	99	89	99
cM capacity (veh/h)	1539			1560			658	692	1034	733	695	1000

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	47	105	26	89
Volume Left	5	32	5	11
Volume Right	0	11	11	5
cSH	1539	1560	788	712
Volume to Capacity	0.00	0.02	0.03	0.13
Queue Length 95th (ft)	0	2	3	11
Control Delay (s)	0.8	2.3	9.7	10.8
Lane LOS	A	A	A	B
Approach Delay (s)	0.8	2.3	9.7	10.8
Approach LOS			A	B

Intersection Summary			
Average Delay	5.6		
Intersection Capacity Utilization	23.3%	ICU Level of Service	A
Analysis Period (min)	15		

20: W 188th Street & Gardner Rd

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	90	30	250	270	30	290	230	1430	250	240	1080	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00		1.00	0.95		0.91	0.91	1.00
Frt	1.00	1.00	0.85	1.00	0.86		1.00	0.98		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1770	1845	1583	1770	1608		1770	3610		1610	3531	1524
Flt Permitted	0.26	1.00	1.00	0.65	1.00		0.23	1.00		0.06	0.70	1.00
Satd. Flow (perm)	484	1845	1583	1213	1608		431	3610		105	2481	1524
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	95	33	263	293	33	315	242	1505	272	261	1137	105
RTOR Reduction (vph)	0	0	106	0	224	0	0	11	0	0	0	44
Lane Group Flow (vph)	95	33	157	293	124	0	242	1766	0	235	1163	61
Heavy Vehicles (%)	2%	3%	2%	2%	3%	2%	2%	3%	2%	2%	3%	6%
Turn Type	pm+pt		Perm	pm+pt			pm+pt			pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	21.4	15.4	15.4	25.4	17.4		70.6	59.4		81.6	81.6	65.4
Effective Green, g (s)	21.4	15.4	15.4	25.4	17.4		70.6	59.4		81.6	81.6	65.4
Actuated g/C Ratio	0.18	0.13	0.13	0.21	0.14		0.59	0.50		0.68	0.68	0.55
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	151	237	203	294	233		379	1787		287	1838	831
v/s Ratio Prot	0.03	0.02		c0.07	0.08		0.06	c0.49		c0.12	c0.09	
v/s Ratio Perm	0.08		0.10	c0.14			0.32			0.44	0.34	0.04
v/c Ratio	0.63	0.14	0.77	1.00	0.53		0.64	0.99		0.82	0.63	0.07
Uniform Delay, d1	43.4	46.4	50.6	46.8	47.5		11.8	30.0		38.2	10.8	12.9
Progression Factor	1.00	1.00	1.00	1.00	1.00		0.95	1.06		1.00	1.00	1.00
Incremental Delay, d2	8.0	0.3	16.5	51.2	2.3		0.3	4.2		16.4	0.7	0.0
Delay (s)	51.3	46.7	67.1	98.0	49.9		11.5	35.8		54.6	11.5	13.0
Level of Service	D	D	E	F	D		B	D		D	B	B
Approach Delay (s)		61.5			71.9			32.9			18.3	
Approach LOS		E			E			C			B	

Intersection Summary			
HCM Average Control Delay	36.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	114.6%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner No Action - PM Peak Hour - Synchro Intersection LOS

21: I-35 SB Ramps & Gardner Rd

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	430	0	1180	20	720	0	0	1210	380
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)				5.0		5.0		5.0			5.0	5.0
Lane Util. Factor				1.00		1.00		1.00			1.00	1.00
Frt				1.00		0.85		1.00			1.00	0.85
Flt Protected				0.95		1.00		1.00			1.00	1.00
Satd. Flow (prot)				1752		1553		1954			1942	1568
Flt Permitted				0.95		1.00		0.42			1.00	1.00
Satd. Flow (perm)				1752		1553		831			1942	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	453	0	1242	21	758	0	0	1274	400
RTOR Reduction (vph)	0	0	0	0	0	104	0	0	0	0	0	104
Lane Group Flow (vph)	0	0	0	453	0	1138	0	779	0	0	1274	296
Heavy Vehicles (%)	0%	0%	0%	3%	0%	4%	10%	2%	0%	0%	3%	3%
Turn Type				custom		custom	Perm					Perm
Protected Phases				8		8		2			6	
Permitted Phases				8		8	2					6
Actuated Green, G (s)				46.0		46.0		64.0			64.0	64.0
Effective Green, g (s)				46.0		46.0		64.0			64.0	64.0
Actuated g/C Ratio				0.38		0.38		0.53			0.53	0.53
Clearance Time (s)				5.0		5.0		5.0			5.0	5.0
Vehicle Extension (s)				3.0		3.0		3.0			3.0	3.0
Lane Grp Cap (vph)				672		595		443			1036	836
v/s Ratio Prot				0.26		c0.73					0.66	
v/s Ratio Perm								c0.94				0.19
v/c Ratio				0.67		1.91		1.76			1.23	0.35
Uniform Delay, d1				30.8		37.0		28.0			28.0	16.1
Progression Factor				1.00		1.00		0.29			0.91	0.48
Incremental Delay, d2				2.7		416.8		342.2			109.3	0.8
Delay (s)				33.4		453.8		350.2			134.7	8.6
Level of Service				C		F		F			F	A
Approach Delay (s)		0.0			341.4			350.2			104.6	
Approach LOS		A			F			F			F	

Intersection Summary			
HCM Average Control Delay	247.5	HCM Level of Service	F
HCM Volume to Capacity ratio	1.82		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	118.4%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

22: I-35 NB Ramps & Gardner Rd

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	190	0	20	0	0	0	0	540	250	760	870	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.99						0.96			1.00	
Flt Protected		0.96						1.00			0.98	
Satd. Flow (prot)		1709						1871			1899	
Flt Permitted		0.96						1.00			0.98	
Satd. Flow (perm)		1709						1871			1899	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	200	0	21	0	0	0	0	568	263	800	916	0
RTOR Reduction (vph)	0	3	0	0	0	0	0	14	0	0	0	0
Lane Group Flow (vph)	0	218	0	0	0	0	0	817	0	0	1716	0
Heavy Vehicles (%)	5%	0%	5%	0%	0%	0%	0%	2%	3%	4%	2%	0%
Turn Type	Split									Split		
Protected Phases	4	4						2		6	6	
Permitted Phases												
Actuated Green, G (s)		16.0						30.0			59.0	
Effective Green, g (s)		16.0						30.0			59.0	
Actuated g/C Ratio		0.13						0.25			0.49	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		228						468			934	
v/s Ratio Prot		c0.13						c0.44			c0.90	
v/s Ratio Perm												
v/c Ratio		0.95						1.75			1.84	
Uniform Delay, d1		51.6						45.0			30.5	
Progression Factor		1.00						1.00			0.79	
Incremental Delay, d2		46.5						344.1			377.1	
Delay (s)		98.1						389.1			401.4	
Level of Service		F						F			F	
Approach Delay (s)		98.1			0.0			389.1			401.4	
Approach LOS		F			A			F			F	

Intersection Summary			
HCM Average Control Delay	373.5	HCM Level of Service	F
HCM Volume to Capacity ratio	1.68		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	149.2%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

23: E 191st Street & Gardner Rd

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	30	140	650	20	70	810
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	32	147	684	21	74	853
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						1000
pX, platoon unblocked	0.52					
vC, conflicting volume	1695	695			705	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1876	695			705	
tC, single (s)	6.4	6.2			4.2	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.3	
p0 queue free %	15	66			92	
cM capacity (veh/h)	37	439			875	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	179	705	926
Volume Left	32	0	74
Volume Right	147	21	0
cSH	151	1700	875
Volume to Capacity	1.19	0.41	0.08
Queue Length 95th (ft)	254	0	7
Control Delay (s)	191.8	0.0	2.2
Lane LOS	F		A
Approach Delay (s)	191.8	0.0	2.2
Approach LOS	F		

Intersection Summary			
Average Delay	20.1		
Intersection Capacity Utilization	102.2%	ICU Level of Service	G
Analysis Period (min)	15		

24: Sunflower Road & US 56

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	50	10	360	20	5	10	120	280	5	180	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.98			1.00			0.91			1.00	
Flt Protected		1.00			0.96			1.00			1.00	
Satd. Flow (prot)		1826			1779			1650			1805	
Flt Permitted		1.00			0.69			0.99			0.99	
Satd. Flow (perm)		1826			1291			1640			1792	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	53	11	379	21	5	11	126	295	5	189	5
RTOR Reduction (vph)	0	7	0	0	1	0	0	70	0	0	1	0
Lane Group Flow (vph)	0	57	0	0	404	0	0	362	0	0	198	0
Heavy Vehicles (%)	0%	2%	0%	2%	0%	0%	0%	8%	3%	0%	5%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		34.6			34.6			45.4			45.4	
Effective Green, g (s)		34.6			34.6			45.4			45.4	
Actuated g/C Ratio		0.38			0.38			0.50			0.50	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		702			496			827			904	
v/s Ratio Prot		0.03										
v/s Ratio Perm					c0.31			c0.22			0.11	
v/c Ratio		0.08			0.82			0.44			0.22	
Uniform Delay, d1		17.6			24.8			14.2			12.4	
Progression Factor		1.00			1.15			0.83			0.54	
Incremental Delay, d2		0.1			7.3			1.6			0.6	
Delay (s)		17.7			35.8			13.4			7.2	
Level of Service		B			D			B			A	
Approach Delay (s)		17.7			35.8			13.4			7.2	
Approach LOS		B			D			B			A	

Intersection Summary			
HCM Average Control Delay	20.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study | 2030 Gardner No-Action
25: US 56 & 4th Street | PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	330	130	90	460	150	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0			5.0	5.0	
Lane Util. Factor	1.00			1.00	1.00	
Frt	0.96			1.00	0.95	
Flt Protected	1.00			0.99	0.97	
Satd. Flow (prot)	1755			1833	1713	
Flt Permitted	1.00			0.85	0.97	
Satd. Flow (perm)	1755			1577	1713	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	347	137	95	484	158	84
RTOR Reduction (vph)	9	0	0	0	29	0
Lane Group Flow (vph)	475	0	0	579	213	0
Heavy Vehicles (%)	5%	2%	2%	3%	2%	3%
Turn Type			Perm			
Protected Phases	4			8	2	
Permitted Phases			8			
Actuated Green, G (s)	63.4			63.4	16.6	
Effective Green, g (s)	63.4			63.4	16.6	
Actuated g/C Ratio	0.70			0.70	0.18	
Clearance Time (s)	5.0			5.0	5.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	1236			1111	316	
v/s Ratio Prot	0.27				c0.12	
v/s Ratio Perm				c0.37		
v/c Ratio	0.38			0.52	0.68	
Uniform Delay, d1	5.4			6.2	34.2	
Progression Factor	1.00			0.54	1.00	
Incremental Delay, d2	0.9			1.6	5.6	
Delay (s)	6.3			4.9	39.8	
Level of Service	A			A	D	
Approach Delay (s)	6.3			4.9	39.8	
Approach LOS	A			A	D	

Intersection Summary			
HCM Average Control Delay	11.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	80.2%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study | 2030 Gardner No-Action
26: 199th Street & Four Corners Road | PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	340	400	90	100	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	11	358	421	95	105	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	516				847	468
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	516				847	468
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				68	98
cM capacity (veh/h)	1060				329	599

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	368	516	116
Volume Left	11	0	105
Volume Right	0	95	11
cSH	1060	1700	343
Volume to Capacity	0.01	0.30	0.34
Queue Length 95th (ft)	1	0	36
Control Delay (s)	0.3	0.0	20.8
Lane LOS	A		C
Approach Delay (s)	0.3	0.0	20.8
Approach LOS			C

Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	39.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2030 Gardner No-Action
27: 199th Street & Gardner Road | PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	170	20	30	260	290	20	120	30	420	200	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00		1.00		1.00	1.00	1.00
Frt	1.00	0.98		1.00	1.00	0.85		0.98		1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.99		0.95	1.00	1.00
Satd. Flow (prot)	1805	1837		1752	1863	1583		1796		1770	1863	1583
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.94		0.41	1.00	1.00
Satd. Flow (perm)	1805	1837		1752	1863	1583		1697		773	1863	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	179	21	32	274	305	21	126	32	442	211	53
RTOR Reduction (vph)	0	5	0	0	0	239	0	9	0	0	0	24
Lane Group Flow (vph)	21	195	0	32	274	66	0	170	0	442	211	29
Heavy Vehicles (%)	0%	2%	0%	3%	2%	2%	0%	3%	3%	2%	2%	2%
Turn Type	Prot			Prot		Perm	Perm			pm+pt		Perm
Protected Phases	5	2		1	6			8		7	4	
Permitted Phases						6	8			4		4
Actuated Green, G (s)	1.5	14.9		1.5	14.9	14.9		12.6		37.6	37.6	37.6
Effective Green, g (s)	1.5	14.9		1.5	14.9	14.9		12.6		37.6	37.6	37.6
Actuated g/C Ratio	0.02	0.22		0.02	0.22	0.22		0.18		0.54	0.54	0.54
Clearance Time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	39	397		38	402	342		310		710	1015	863
v/s Ratio Prot	0.01	c0.11		0.02	c0.15					c0.18	0.11	
v/s Ratio Perm						0.04		0.10		c0.16		0.02
v/c Ratio	0.54	0.49		0.84	0.68	0.19		0.55		0.62	0.21	0.03
Uniform Delay, d1	33.4	23.7		33.6	24.9	22.1		25.6		10.5	8.1	7.3
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00		1.00	1.00	1.00
Incremental Delay, d2	13.5	1.0		85.4	4.7	0.3		2.0		1.7	0.1	0.0
Delay (s)	47.0	24.7		119.0	29.6	22.4		27.6		12.2	8.2	7.3
Level of Service	D	C		F	C	C		C		B	A	A
Approach Delay (s)		26.8			30.7			27.6			10.6	
Approach LOS		C			C			C			B	

Intersection Summary			
HCM Average Control Delay	21.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	69.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	66.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study | 2030 Gardner No-Action
30: US-56 & I-35 NB Loop | PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	1530	1350	0	1900	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	1611	1421	0	2000	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked					0.61	
vC, conflicting volume			3032		2611	805
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			3032		2365	805
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			114		19	330

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	805	805	1421	1000	1000
Volume Left	0	0	0	0	0
Volume Right	0	0	1421	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.47	0.47	0.84	0.59	0.59
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	86.9%	ICU Level of Service	E
Analysis Period (min)	15		

2030 Gardner No Action - PM Peak Hour - Synchro Intersection LOS

37: 199th Street & West Waverley

PM Peak Hour

Movement	EBL	EBT	WBU	WBT	WBR	SBL	SBR
Lane Configurations							
Volume (veh/h)	0	720	0	770	10	90	0
Sign Control		Free		Free		Stop	
Grade		0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	783	0	837	11	98	0
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type		TWLTL		TWLTL			
Median storage veh)		2		2			
Upstream signal (ft)				802			
pX, platoon unblocked			0.00				
vC, conflicting volume	848		0			1625	842
vC1, stage 1 conf vol						842	
vC2, stage 2 conf vol						783	
vCu, unblocked vol	848		0			1625	842
tC, single (s)	4.1		0.0			6.4	6.2
tC, 2 stage (s)						5.4	
tF (s)	2.2		0.0			3.5	3.3
p0 queue free %	100		0			69	100
cM capacity (veh/h)	798		0			320	367

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	0	783	848	0	98
Volume Left	0	0	0	0	98
Volume Right	0	0	11	0	0
cSH	1700	1700	1700	1700	320
Volume to Capacity	0.00	0.46	0.50	0.00	0.31
Queue Length 95th (ft)	0	0	0	0	32
Control Delay (s)	0.0	0.0	0.0	0.0	21.1
Lane LOS					C
Approach Delay (s)	0.0		0.0		21.1
Approach LOS					C

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	52.8%	ICU Level of Service	A
Analysis Period (min)	15		

38: 199th Street & IH-35 SB Ramp

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	600	210	140	190	0	0	0	0	10	0	600
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		2.5		2.5	2.5					2.5		2.5
Lane Util. Factor		1.00		1.00	1.00					1.00		1.00
Frt		0.97		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		1798		1770	1863					1805		1583
Flt Permitted		1.00		0.22	1.00					0.95		1.00
Satd. Flow (perm)		1798		410	1863					1805		1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	652	228	152	207	0	0	0	0	11	0	652
RTOR Reduction (vph)	0	8	0	0	0	0	0	0	0	0	0	598
Lane Group Flow (vph)	0	872	0	152	207	0	0	0	0	11	0	54
Heavy Vehicles (%)	0%	2%	2%	2%	2%	0%	0%	0%	0%	0%	0%	2%
Turn Type				pm+pt						Prot		custom
Protected Phases		4		3	8					6		
Permitted Phases				8								6
Actuated Green, G (s)		65.4		77.5	77.5					7.5		7.5
Effective Green, g (s)		65.4		77.5	77.5					7.5		7.5
Actuated g/C Ratio		0.73		0.86	0.86					0.08		0.08
Clearance Time (s)		2.5		2.5	2.5					2.5		2.5
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		1307		498	1604					150		132
v/s Ratio Prot		c0.48		c0.03	0.11					0.01		
v/s Ratio Perm				0.23								c0.03
v/c Ratio		0.67		0.31	0.13					0.07		0.41
Uniform Delay, d1		6.5		5.0	1.0					38.0		39.2
Progression Factor		0.93		4.43	0.78					1.00		1.00
Incremental Delay, d2		2.7		0.3	0.0					0.2		2.1
Delay (s)		8.7		22.5	0.8					38.3		41.2
Level of Service		A		C	A					D		D
Approach Delay (s)		8.7			10.0			0.0			41.2	
Approach LOS		A			A			A			D	

Intersection Summary			
HCM Average Control Delay	20.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	7.5
Intersection Capacity Utilization	65.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

39: 199th Street & IH-35 NB Ramp

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	500	120	0	0	280	20	50	0	50	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		2.5		2.5			
Lane Util. Factor	1.00	1.00			1.00		1.00		1.00			
Frt	1.00	1.00			0.99		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1770	1863			1848		1770		1583			
Flt Permitted	0.50	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	929	1863			1848		1770		1583			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	543	130	0	0	304	22	54	0	54	0	0	0
RTOR Reduction (vph)	0	0	0	0	2	0	0	0	50	0	0	0
Lane Group Flow (vph)	543	130	0	0	324	0	54	0	4	0	0	0
Heavy Vehicles (%)	2%	2%	0%	0%	2%	0%	2%	0%	2%	0%	0%	0%
Turn Type	pm+pt						Prot		custom			
Protected Phases	7	4			8		5					
Permitted Phases	4								5			
Actuated Green, G (s)	75.4	75.4			57.6		7.1		7.1			
Effective Green, g (s)	75.4	75.4			57.6		7.1		7.1			
Actuated g/C Ratio	0.84	0.84			0.64		0.08		0.08			
Clearance Time (s)	5.0	5.0			5.0		2.5		2.5			
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Lane Grp Cap (vph)	898	1561			1183		140		125			
v/s Ratio Prot	c0.09	0.07			0.18		c0.03					
v/s Ratio Perm	c0.42								0.00			
v/c Ratio	0.60	0.08			0.27		0.39		0.03			
Uniform Delay, d1	2.3	1.3			7.1		39.4		38.3			
Progression Factor	1.58	0.88			1.00		1.00		1.00			
Incremental Delay, d2	0.9	0.1			0.1		1.8		0.1			
Delay (s)	4.5	1.2			7.2		41.1		38.4			
Level of Service	A	A			A		D		D			
Approach Delay (s)		3.9			7.2			39.8			0.0	
Approach LOS		A			A			D			A	

Intersection Summary			
HCM Average Control Delay	8.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	7.5
Intersection Capacity Utilization	65.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

40: 199th Street & East Waverley

PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	160	10	5	290	10	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	174	11	5	315	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	820					
pX, platoon unblocked						
vC, conflicting volume			185		505	179
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			185		505	179
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	99
cM capacity (veh/h)			1402		528	869

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	185	321	16
Volume Left	0	5	11
Volume Right	11	0	5
cSH	1700	1402	607
Volume to Capacity	0.11	0.00	0.03
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.2	11.1
Lane LOS		A	B
Approach Delay (s)	0.0	0.2	11.1
Approach LOS			B

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	29.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study
1: 175th Street & Waverly Road

2030 Gardner No-Action - (Improved)
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Volume (vph)	50	10	330	10	20	30	630	210	10	10	130	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.91		1.00	0.99		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1677		1805	1819		1770	3517		1805	3407	
Flt Permitted	0.72	1.00		0.41	1.00		0.57	1.00		0.61	1.00	
Satd. Flow (perm)	1346	1677		784	1819		1071	3517		1154	3407	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	53	11	347	11	21	32	663	221	11	11	137	42
RTOR Reduction (vph)	0	310	0	0	29	0	0	3	0	0	20	0
Lane Group Flow (vph)	53	48	0	11	24	0	663	229	0	11	159	0
Heavy Vehicles (%)	2%	0%	2%	0%	0%	0%	2%	2%	0%	0%	2%	3%
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	9.7	9.7		9.7	9.7		70.3	64.5		45.7	44.9	
Effective Green, g (s)	9.7	9.7		9.7	9.7		70.3	64.5		45.7	44.9	
Actuated g/C Ratio	0.11	0.11		0.11	0.11		0.78	0.72		0.51	0.50	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	145	181		84	196		995	2521		592	1700	
v/s Ratio Prot		0.03			0.01		c0.15	0.07		0.00	0.05	
v/s Ratio Perm	c0.04			0.01			c0.37			0.01		
v/c Ratio	0.37	0.27		0.13	0.12		0.67	0.09		0.02	0.09	
Uniform Delay, d1	37.3	36.9		36.3	36.3		3.8	3.9		11.0	11.9	
Progression Factor	1.00	1.00		1.00	1.00		0.93	0.58		1.00	1.00	
Incremental Delay, d2	1.6	0.8		0.7	0.3		1.5	0.1		0.0	0.1	
Delay (s)	38.9	37.7		37.0	36.6		5.0	2.3		11.0	12.0	
Level of Service	D	D		D	D		A	A		B	B	
Approach Delay (s)		37.8			36.7			4.3			11.9	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM Average Control Delay	15.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	72.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
2: US 56 & Gardner Road

2030 Gardner No-Action - (Improved)
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↑	↱	↰	↑↑	↱	↰↰	↑↱	
Volume (vph)	130	440	60	300	890	440	50	890	220	320	930	120
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3551	1583	1770	3689	1583	1770	3725	1568	3400	3479	
Flt Permitted	0.17	1.00	1.00	0.35	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	317	3551	1583	661	3689	1583	1770	3725	1568	3400	3479	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	463	63	316	937	463	53	937	232	337	979	126
RTOR Reduction (vph)	0	0	47	0	0	249	0	0	162	0	11	0
Lane Group Flow (vph)	137	463	16	316	937	214	53	937	70	337	1094	0
Heavy Vehicles (%)	2%	7%	2%	2%	3%	2%	2%	2%	3%	3%	2%	2%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			
Actuated Green, G (s)	29.3	23.5	23.5	37.3	29.0	29.0	4.4	27.2	27.2	11.3	34.1	
Effective Green, g (s)	29.3	23.5	23.5	37.3	29.0	29.0	4.4	27.2	27.2	11.3	34.1	
Actuated g/C Ratio	0.33	0.26	0.26	0.41	0.32	0.32	0.05	0.30	0.30	0.13	0.38	
Clearance Time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	197	927	413	413	1189	510	87	1126	474	427	1318	
v/s Ratio Prot	0.04	0.13		c0.10	c0.25		0.03	c0.25		0.10	c0.31	
v/s Ratio Perm	0.18		0.01	0.22		0.13			0.04			
v/c Ratio	0.70	0.50	0.04	0.77	0.79	0.42	0.61	0.83	0.15	0.79	0.83	
Uniform Delay, d1	23.1	28.3	24.8	19.3	27.7	23.9	42.0	29.3	22.9	38.2	25.3	
Progression Factor	1.18	0.70	0.67	0.67	0.80	0.60	0.85	0.72	1.75	1.00	1.00	
Incremental Delay, d2	9.9	1.9	0.2	5.9	3.8	1.8	6.8	3.2	0.1	9.4	4.5	
Delay (s)	37.2	21.8	16.8	18.8	26.0	16.0	42.3	24.2	40.2	47.6	29.8	
Level of Service	D	C	B	B	C	B	D	C	D	D	C	
Approach Delay (s)		24.5			22.0			28.0			34.0	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	27.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	14.1
Intersection Capacity Utilization	79.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
3: US 56 & Elm

2030 Gardner No-Action - (Improved)
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱			↰↑↱		↰	↱		↰	↱	
Volume (vph)	10	970	30	40	1630	40	20	10	50	100	20	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			1.00		1.00	0.88		1.00	0.91	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3424			3521		1719	1637		1770	1697	
Flt Permitted		0.93			0.90		0.72	1.00		0.72	1.00	
Satd. Flow (perm)		3173			3162		1307	1637		1332	1697	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	11	1021	32	42	1716	42	21	11	53	105	21	32
RTOR Reduction (vph)	0	2	0	0	1	0	0	47	0	0	25	0
Lane Group Flow (vph)	0	1062	0	0	1799	0	21	17	0	105	28	0
Heavy Vehicles (%)	0%	5%	3%	3%	2%	3%	5%	0%	2%	2%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		70.0			70.0		11.0	11.0		11.0	11.0	
Effective Green, g (s)		70.0			70.0		11.0	11.0		11.0	11.0	
Actuated g/C Ratio		0.78			0.78		0.12	0.12		0.12	0.12	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2468			2459		160	200		163	207	
v/s Ratio Prot								0.01			0.02	
v/s Ratio Perm		0.33			c0.57		0.02			c0.08		
v/c Ratio		0.43			0.73		0.13	0.09		0.64	0.14	
Uniform Delay, d1		3.3			5.2		35.2	35.0		37.6	35.3	
Progression Factor		1.89			0.65		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.5			1.4		0.4	0.2		8.4	0.3	
Delay (s)		6.8			4.8		35.6	35.2		46.1	35.6	
Level of Service		A			A		D	D		D	D	
Approach Delay (s)		6.8			4.8			35.3			42.5	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	8.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	94.8%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
4: US 56 & Mulberry

2030 Gardner No-Action - (Improved)
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱			↰↑↱		↰	↱		↰	↱	
Volume (vph)	20	1100	10	30	1740	40	10	5	20	40	10	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			1.00		1.00	0.88		1.00	0.90	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3467			3523		1805	1605		1752	1713	
Flt Permitted		0.88			0.91		0.74	1.00		0.74	1.00	
Satd. Flow (perm)		3069			3215		1399	1605		1366	1713	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	1158	11	32	1832	42	11	5	21	42	11	21
RTOR Reduction (vph)	0	1	0	0	2	0	0	20	0	0	20	0
Lane Group Flow (vph)	0	1189	0	0	1904	0	11	6	0	42	12	0
Heavy Vehicles (%)	0%	4%	0%	3%	2%	3%	0%	0%	5%	3%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		75.5			75.5		5.5	5.5		5.5	5.5	
Effective Green, g (s)		75.5			75.5		5.5	5.5		5.5	5.5	
Actuated g/C Ratio		0.84			0.84		0.06	0.06		0.06	0.06	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2575			2697		85	98		83	105	
v/s Ratio Prot								0.00			0.01	
v/s Ratio Perm		0.39			c0.59		0.01			c0.03		
v/c Ratio		0.46			0.71		0.13	0.06		0.51	0.12	
Uniform Delay, d1		1.9			2.9		40.0	39.8		40.9	40.0	
Progression Factor		0.17			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.6			1.6		0.7	0.3		4.8	0.5	
Delay (s)		0.9			4.4		40.7	40.1		45.7	40.5	
Level of Service		A			A		D	D		D	D	
Approach Delay (s)		0.9			4.4			40.3			43.4	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	4.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	87.1%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
5: US 56 & Moonlight Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	150	760	250	370	1530	1280	200	550	160	730	730	170
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1752	3619	1583	1770	3725	1583	1770	3725	1583	3433	3539	1583
Flt Permitted	0.10	1.00	1.00	0.17	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	181	3619	1583	325	3725	1583	1770	3725	1583	3433	3539	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	158	800	263	389	1611	1347	211	579	168	768	768	179
RTOR Reduction (vph)	0	0	126	0	0	315	0	0	116	0	0	84
Lane Group Flow (vph)	158	800	137	389	1611	1032	211	579	52	768	768	95
Heavy Vehicles (%)	3%	5%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		custom	Prot		Perm
Protected Phases	5	2		1	6		3	8	8	7	4	
Permitted Phases	2		2	6		6			8			4
Actuated Green, G (s)	46.3	40.8	40.8	67.5	56.5	56.5	11.5	15.5	15.5	19.5	23.5	23.5
Effective Green, g (s)	46.3	40.8	40.8	67.5	56.5	56.5	11.5	15.5	15.5	19.5	23.5	23.5
Actuated g/C Ratio	0.39	0.34	0.34	0.56	0.47	0.47	0.10	0.13	0.13	0.16	0.20	0.20
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	142	1230	538	438	1754	745	170	481	204	558	693	310
v/s Ratio Prot	0.05	0.22		c0.16	0.43		0.12	c0.16	0.03	c0.22	0.22	
v/s Ratio Perm	0.38		0.09	0.34		c0.65						0.06
v/c Ratio	1.11	0.65	0.25	0.89	0.92	1.39	1.24	1.20	0.26	1.38	1.11	0.31
Uniform Delay, d1	34.0	33.6	28.6	24.3	29.6	31.8	54.2	52.2	47.1	50.2	48.2	41.3
Progression Factor	1.00	1.00	1.00	1.00	0.89	0.96	0.89	0.90	0.79	1.00	1.00	1.00
Incremental Delay, d2	109.0	2.7	1.1	5.9	2.7	175.6	145.1	108.5	0.2	180.4	67.8	0.2
Delay (s)	142.9	36.2	29.8	30.1	29.2	206.2	193.6	155.3	37.2	230.7	116.1	41.5
Level of Service	F	D	C	C	C	F	F	F	D	F	F	D
Approach Delay (s)		48.6			100.5			143.1			159.6	
Approach LOS		D			F			F			F	

Intersection Summary			
HCM Average Control Delay	111.4	HCM Level of Service	F
HCM Volume to Capacity ratio	1.35		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	116.6%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
6: Old US 56 & US 56 — PM Peak Hour

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	730	20	1360	290	10	2440
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	0.97	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	3433	1538	3654	1568	1805	3725
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	3433	1538	3654	1568	1805	3725
Peak-hour factor, PHF	0.97	0.97	0.95	0.95	0.95	0.95
Adj. Flow (vph)	753	21	1432	305	11	2568
RTOR Reduction (vph)	0	16	0	41	0	0
Lane Group Flow (vph)	753	5	1432	264	11	2568
Heavy Vehicles (%)	2%	5%	4%	3%	0%	2%
Turn Type		Perm		pm+ov	Prot	
Protected Phases	8		2	8	1	6
Permitted Phases		8	2	2		6
Actuated Green, G (s)	27.0	27.0	76.8	103.8	1.2	83.0
Effective Green, g (s)	27.0	27.0	76.8	103.8	1.2	83.0
Actuated g/C Ratio	0.22	0.22	0.64	0.86	0.01	0.69
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	772	346	2339	1422	18	2576
v/s Ratio Prot	c0.22		0.39	0.04	0.01	c0.69
v/s Ratio Perm		0.00		0.13		
v/c Ratio	0.98	0.01	0.61	0.19	0.61	1.00
Uniform Delay, d1	46.2	36.1	12.8	1.3	59.2	18.4
Progression Factor	1.00	1.00	0.97	0.00	0.83	0.40
Incremental Delay, d2	26.2	0.0	0.4	0.0	32.3	13.1
Delay (s)	72.3	36.2	12.8	0.0	81.2	20.4
Level of Service	E	D	B	A	F	C
Approach Delay (s)	71.4		10.6			20.6
Approach LOS	E		B			C

Intersection Summary			
HCM Average Control Delay	24.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	93.2%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
7: US-56 & Cedar Niles — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	60	2120	190	790	1990	60	210	20	850	60	20	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2	5.2	5.2	5.2	5.2
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00	1.00	1.00	0.88	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3689	1583	3433	3689	1583	1770	2000	2787	1770	2000	1568
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.74	1.00	1.00	0.74	1.00	1.00
Satd. Flow (perm)	1770	3689	1583	3433	3689	1583	1385	2000	2787	1385	2000	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	63	2232	200	832	2095	63	221	21	895	63	21	42
RTOR Reduction (vph)	0	0	77	0	0	18	0	0	0	0	0	36
Lane Group Flow (vph)	63	2232	123	832	2095	45	221	21	895	63	21	6
Heavy Vehicles (%)	2%	3%	2%	2%	3%	2%	2%	0%	2%	2%	0%	3%
Turn Type	Prot		Perm	Prot		Perm	Perm		pt+ov	Perm		Perm
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases			2			6	8			4		4
Actuated Green, G (s)	5.6	62.6	62.6	25.0	82.0	82.0	16.8	16.8	47.0	16.8	16.8	16.8
Effective Green, g (s)	5.6	62.6	62.6	25.0	82.0	82.0	16.8	16.8	47.0	16.8	16.8	16.8
Actuated g/C Ratio	0.05	0.52	0.52	0.21	0.68	0.68	0.14	0.14	0.39	0.14	0.14	0.14
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2		5.2	5.2	5.2
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lane Grp Cap (vph)	83	1924	826	715	2521	1082	194	280	1092	194	280	220
v/s Ratio Prot	0.04	c0.60		c0.24	0.57			0.01	0.32		0.01	
v/s Ratio Perm			0.08			0.03	c0.16			0.05		0.00
v/c Ratio	0.76	1.16	0.15	1.16	0.83	0.04	1.14	0.08	0.82	0.32	0.08	0.03
Uniform Delay, d1	56.5	28.7	14.9	47.5	13.9	6.2	51.6	44.8	32.7	46.5	44.8	44.5
Progression Factor	0.72	0.42	0.04	0.99	0.81	0.74	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	28.1	78.0	0.4	75.2	0.3	0.0	107.1	0.0	4.7	0.4	0.0	0.0
Delay (s)	68.9	90.2	0.9	122.5	11.5	4.6	158.7	44.9	37.4	46.8	44.9	44.6
Level of Service	E	F	A	F	B	A	F	D	D	D	D	D
Approach Delay (s)		82.5			42.3			61.1			45.8	
Approach LOS		F			D			E			D	

Intersection Summary			
HCM Average Control Delay	60.4	HCM Level of Service	E
HCM Volume to Capacity ratio	1.16		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.6
Intersection Capacity Utilization	109.5%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
8: US-56 & I-35 SB Ramps — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	2720	280	660	1250	0	0	0	0	170	0	1560
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		0.99		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3486		1752	3725					1770		2787
Flt Permitted		1.00		0.18	1.00					0.95		1.00
Satd. Flow (perm)		3486		337	3725					1770		2787
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2863	295	695	1316	0	0	0	0	179	0	1642
RTOR Reduction (vph)	0	7	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	3151	0	695	1316	0	0	0	0	179	0	1642
Heavy Vehicles (%)	0%	2%	3%	3%	2%	0%	0%	0%	0%	2%	0%	2%
Turn Type				pm+pt						custom		custom
Protected Phases		2		1	6					4		5
Permitted Phases				6						4		4
Actuated Green, G (s)		71.0		45.9	45.9					10.0		59.1
Effective Green, g (s)		71.0		45.9	45.9					10.0		59.1
Actuated g/C Ratio		0.59		0.38	0.38					0.08		0.49
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2063		412	1425					148		1489
v/s Ratio Prot		c0.90		c0.34	0.35					0.10		c0.45
v/s Ratio Perm				c0.31								0.14
v/c Ratio		1.53		1.69	0.92					1.21		1.10
Uniform Delay, d1		24.5		34.9	35.4					55.0		30.4
Progression Factor		0.82		0.97	0.92					1.00		1.00
Incremental Delay, d2		237.7		316.4	7.6					141.2		56.8
Delay (s)		257.7		350.0	40.2					196.2		87.3
Level of Service		F		F	D					F		F
Approach Delay (s)		257.7			147.3			0.0			98.0	
Approach LOS		F			F			A			F	

Intersection Summary			
HCM Average Control Delay	184.3	HCM Level of Service	F
HCM Volume to Capacity ratio	1.45		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	5.0
Intersection Capacity Utilization	141.8%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner No Action - (Improved) - PM Peak Hour - Synchro Intersection LOS

9: US-56 & I-35 NB Ramps

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1530	0	0	1810	580	100	0	390	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95	0.95			
Frt		1.00			1.00	0.85	1.00	0.85	0.85			
Flt Protected		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (prot)		3725			3539	1538	1703	1421	1421			
Flt Permitted		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (perm)		3725			3539	1538	1703	1421	1421			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1611	0	0	1905	611	105	0	411	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	106	0	0	0	0	0	0
Lane Group Flow (vph)	0	1611	0	0	1905	505	105	206	205	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	5%	6%	0%	8%	0%	0%	0%
Turn Type						Perm	Perm		Perm			
Protected Phases		2			6			8				
Permitted Phases						6	8		8			
Actuated Green, G (s)		87.7			87.7	87.7	22.3	22.3	22.3			
Effective Green, g (s)		87.7			87.7	87.7	22.3	22.3	22.3			
Actuated g/C Ratio		0.73			0.73	0.73	0.19	0.19	0.19			
Clearance Time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0	3.0			
Lane Grp Cap (vph)		2722			2586	1124	316	264	264			
v/s Ratio Prot		0.43			c0.54			c0.15				
v/s Ratio Perm						0.33	0.06		0.14			
v/c Ratio		0.59			0.74	0.45	0.33	0.78	0.78			
Uniform Delay, d1		7.7			9.4	6.5	42.4	46.5	46.5			
Progression Factor		0.35			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2		0.1			1.1	0.3	0.6	13.8	13.3			
Delay (s)		2.8			10.5	6.8	43.0	60.4	59.8			
Level of Service		A			B	A	D	E	E			
Approach Delay (s)		2.8			9.6			56.6			0.0	
Approach LOS		A			A			E			A	

Intersection Summary			
HCM Average Control Delay	12.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	86.9%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

10: Santa Fe & Moonlight Road

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	240	480	440	160	380	930
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.96		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3398		1770	3539
Flt Permitted	0.95	1.00	1.00		0.38	1.00
Satd. Flow (perm)	1770	1583	3398		700	3539
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	253	505	463	168	400	979
RTOR Reduction (vph)	0	407	18	0	0	0
Lane Group Flow (vph)	253	98	613	0	400	979
Turn Type		Perm			pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8			6	
Actuated Green, G (s)	23.2	23.2	68.9		86.8	86.8
Effective Green, g (s)	23.2	23.2	68.9		86.8	86.8
Actuated g/C Ratio	0.19	0.19	0.57		0.72	0.72
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	342	306	1951		621	2560
v/s Ratio Prot	c0.14		0.18		c0.07	0.28
v/s Ratio Perm		0.06			c0.40	
v/c Ratio	0.74	0.32	0.31		0.64	0.38
Uniform Delay, d1	45.6	41.6	13.3		13.7	6.3
Progression Factor	1.00	1.00	1.00		0.82	0.76
Incremental Delay, d2	8.1	0.6	0.4		1.0	0.2
Delay (s)	53.7	42.2	13.7		12.2	5.0
Level of Service	D	D	B		B	A
Approach Delay (s)	46.0		13.7			7.1
Approach LOS	D		B			A

Intersection Summary			
HCM Average Control Delay	19.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

11: Waverly Road & US 56

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	150	20	310	110	40	60	130	0	30	190	630
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor		0.95	1.00	0.97	0.95		1.00	0.95		1.00	0.95	1.00
Frt		1.00	0.85	1.00	0.96		1.00	1.00		1.00	1.00	0.85
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)		3539	1615	3400	3372		1770	3282		1752	3438	1583
Flt Permitted		1.00	1.00	0.95	1.00		0.60	1.00		0.67	1.00	1.00
Satd. Flow (perm)		3539	1615	3400	3372		1117	3282		1227	3438	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	158	21	326	116	42	63	137	0	32	200	663
RTOR Reduction (vph)	0	0	19	0	29	0	0	0	0	0	0	362
Lane Group Flow (vph)	0	158	2	326	129	0	63	137	0	32	200	301
Heavy Vehicles (%)	0%	2%	0%	3%	2%	5%	2%	10%	0%	3%	5%	2%
Turn Type	Perm		Perm	Prot			pm+pt		Perm	pm+pt		Perm
Protected Phases		8		7	4		5	2		1	6	
Permitted Phases	8		8				2	2	2	6		6
Actuated Green, G (s)		9.4	9.4	13.8	28.2		48.6	42.7		45.0	40.9	40.9
Effective Green, g (s)		9.4	9.4	13.8	28.2		48.6	42.7		45.0	40.9	40.9
Actuated g/C Ratio		0.10	0.10	0.15	0.31		0.54	0.47		0.50	0.45	0.45
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)		370	169	521	1057		646	1557		637	1562	719
v/s Ratio Prot		c0.04		c0.10	0.04		c0.01	0.04		0.00	0.06	
v/s Ratio Perm			0.00				0.05			0.02		c0.19
v/c Ratio		0.43	0.01	0.63	0.12		0.10	0.09		0.05	0.13	0.42
Uniform Delay, d1		37.8	36.1	35.7	22.1		9.9	13.0		11.5	14.2	16.5
Progression Factor		1.00	0.97	0.92	0.82		1.18	1.18		0.36	0.34	3.09
Incremental Delay, d2		0.8	0.0	2.2	0.0		0.1	0.1		0.0	0.1	1.1
Delay (s)		38.4	35.0	35.1	18.2		11.8	15.5		4.1	5.0	52.3
Level of Service		D	C	D	B		B	B		A	A	D
Approach Delay (s)		38.0			29.6			14.3			40.0	
Approach LOS		D			C			B			D	

Intersection Summary			
HCM Average Control Delay	34.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	59.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

12: 183rd Street & Four Corners Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	50	40	0	40	30	10	180	0	5	110	5
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	53	42	0	42	32	11	189	0	5	116	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	100	74	200	126
Volume Left (vph)	5	0	11	5
Volume Right (vph)	42	32	0	5
Hadj (s)	-0.20	-0.21	0.04	0.01
Departure Headway (s)	4.6	4.6	4.5	4.6
Degree Utilization, x	0.13	0.09	0.25	0.16
Capacity (veh/h)	726	719	764	744
Control Delay (s)	8.2	8.1	9.0	8.4
Approach Delay (s)	8.2	8.1	9.0	8.4
Approach LOS	A	A	A	A

Intersection Summary			
Delay	8.6		
HCM Level of Service	A		
Intersection Capacity Utilization	29.3%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner No Action - (Improved) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
13: 183rd Street & US 56
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	40	20	5	20	50	5	0	160	30	5	210	20
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	42	21	5	21	53	5	0	168	32	5	221	21
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	458	442	232	442	437	184	242			200		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	458	442	232	442	437	184	242			200		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	91	96	99	96	90	99	100			100		
cM capacity (veh/h)	467	511	813	508	511	863	1336			1384		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	68	79	200	247
Volume Left	42	21	0	5
Volume Right	5	5	32	21
cSH	496	525	1336	1384
Volume to Capacity	0.14	0.15	0.00	0.00
Queue Length 95th (ft)	12	13	0	0
Control Delay (s)	13.4	13.1	0.0	0.2
Lane LOS	B	B		A
Approach Delay (s)	13.4	13.1	0.0	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	3.4		
Intersection Capacity Utilization	30.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
14: 183rd Street & Waverly Road
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	30	20	5	20	50	10	5	180	30	5	210	20
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	32	21	5	21	53	11	5	189	32	5	221	21
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	63			26			318	192	24	313	189	58
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	63			26			318	192	24	313	189	58
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	98			99			99	72	97	99	68	98
cM capacity (veh/h)	1533			1601			457	679	1050	478	682	1014

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	58	84	226	247
Volume Left	32	21	5	5
Volume Right	5	11	32	21
cSH	1533	1601	706	695
Volume to Capacity	0.02	0.01	0.32	0.36
Queue Length 95th (ft)	2	1	35	40
Control Delay (s)	4.1	1.9	12.5	13.0
Lane LOS	A	A	B	B
Approach Delay (s)	4.1	1.9	12.5	13.0
Approach LOS			B	B

Intersection Summary			
Average Delay	10.5		
Intersection Capacity Utilization	27.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
15: 183rd Street & Gardner Road
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	130	120	110	170	120	100	170	980	280	140	950	120
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.93		1.00	0.93		1.00	0.97		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1729		1770	1736		1770	3395		1770	3450	
Flt Permitted	0.36	1.00		0.35	1.00		0.21	1.00		0.12	1.00	
Satd. Flow (perm)	667	1729		647	1736		384	3395		217	3450	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	126	116	179	126	105	179	1032	295	147	1000	126
RTOR Reduction (vph)	0	38	0	0	0	0	0	29	0	0	10	0
Lane Group Flow (vph)	137	204	0	179	231	0	179	1298	0	147	1116	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	3%	2%	2%	3%	2%
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	19.7	14.2		22.9	15.8		41.3	41.3		41.7	41.7	
Effective Green, g (s)	19.7	14.2		22.9	15.8		41.3	41.3		41.7	41.7	
Actuated g/C Ratio	0.22	0.16		0.25	0.18		0.46	0.46		0.46	0.46	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	213	273		253	305		284	1558		228	1599	
v/s Ratio Prot	0.04	0.12		c0.06	c0.13		0.05	c0.38		0.05	c0.32	
v/s Ratio Perm	0.10			0.12			0.24			0.25		
v/c Ratio	0.64	0.75		0.71	0.76		0.63	0.83		0.64	0.70	
Uniform Delay, d1	35.9	36.2		34.5	35.3		25.6	21.3		19.7	19.2	
Progression Factor	1.00	1.00		1.00	1.00		0.55	0.44		1.49	0.38	
Incremental Delay, d2	6.5	10.6		8.7	10.3		1.2	1.5		3.8	1.6	
Delay (s)	42.5	46.8		43.2	45.5		15.2	10.9		33.2	8.9	
Level of Service	D	D		D	D		B	B		C	A	
Approach Delay (s)		45.2			44.5			11.4			11.7	
Approach LOS		D			D			B			B	

Intersection Summary			
HCM Average Control Delay	18.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	82.9%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
16: Four Corners Road & US 56
PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	130	60	0	120	20	50	130	5	70	160	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	137	63	0	126	21	53	137	5	74	168	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	645	561	139	692	563	168	168			142		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	645	561	139	692	563	168	168			142		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	66	93	100	68	98	96			95		
cM capacity (veh/h)	268	399	909	231	398	881	1409			1447		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	205	147	195	242
Volume Left	5	0	53	74
Volume Right	63	21	5	0
cSH	475	431	1409	1447
Volume to Capacity	0.43	0.34	0.04	0.05
Queue Length 95th (ft)	54	37	3	4
Control Delay (s)	18.2	17.6	2.3	2.6
Lane LOS	C	C	A	A
Approach Delay (s)	18.2	17.6	2.3	2.6
Approach LOS	C	C		

Intersection Summary			
Average Delay	9.4		
Intersection Capacity Utilization	38.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
17: 191st Street & US 56 — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	50	10	0	10	10	0	0	120	5	0	160	20
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	53	11	0	11	11	0	0	126	5	0	168	21
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	313	311	179	313	318	129	189			132		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	313	311	179	313	318	129	189			132		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	92	98	100	98	98	100	100			100		
cM capacity (veh/h)	631	607	869	635	601	926	1397			1466		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	63	21	132	189
Volume Left	53	11	0	0
Volume Right	0	0	5	21
cSH	627	618	1397	1466
Volume to Capacity	0.10	0.03	0.00	0.00
Queue Length 95th (ft)	8	3	0	0
Control Delay (s)	11.4	11.0	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	11.4	11.0	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	21.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
18: 191st Street & Four Corners Road — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	5	35	195	5	100	100
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	37	205	5	105	105
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	524	208			211	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	524	208			211	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	96			92	
cM capacity (veh/h)	477	830			1360	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	42	211	211
Volume Left	5	0	105
Volume Right	37	5	0
cSH	760	1700	1360
Volume to Capacity	0.06	0.12	0.08
Queue Length 95th (ft)	4	0	6
Control Delay (s)	10.0	0.0	4.3
Lane LOS	B		A
Approach Delay (s)	10.0	0.0	4.3
Approach LOS	B		

Intersection Summary			
Average Delay	2.8		
Intersection Capacity Utilization	34.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
19: 191st Street & Waverly Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	40	0	30	60	10	5	10	10	10	70	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	42	0	32	63	11	5	11	11	11	74	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	74			42			226	189	42	200	184	68
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	74			42			226	189	42	200	184	68
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			98			99	98	99	99	89	99
cM capacity (veh/h)	1539			1560			658	692	1034	733	695	1000

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	47	105	26	89
Volume Left	5	32	5	11
Volume Right	0	11	11	5
cSH	1539	1560	788	712
Volume to Capacity	0.00	0.02	0.03	0.13
Queue Length 95th (ft)	0	2	3	11
Control Delay (s)	0.8	2.3	9.7	10.8
Lane LOS	A	A	A	B
Approach Delay (s)	0.8	2.3	9.7	10.8
Approach LOS			A	B

Intersection Summary			
Average Delay	5.6		
Intersection Capacity Utilization	23.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
20: W 188th Street & Gardner Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	90	30	250	270	30	290	230	1430	250	240	1080	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	5.0	5.0	5.0	2.5	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.86		1.00	0.98		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1770	1845	1583	1770	1608		1770	3610		1770	3689	1524
Flt Permitted	0.34	1.00	1.00	0.61	1.00		0.14	1.00		0.09	1.00	1.00
Satd. Flow (perm)	626	1845	1583	1132	1608		264	3610		175	3689	1524
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	95	33	263	293	33	315	242	1505	272	261	1137	105
RTOR Reduction (vph)	0	0	197	0	176	0	0	17	0	0	0	55
Lane Group Flow (vph)	95	33	66	293	172	0	242	1760	0	261	1137	50
Heavy Vehicles (%)	2%	3%	2%	2%	3%	2%	2%	3%	2%	2%	3%	6%
Turn Type	pm+pt		Perm	pm+pt			pm+pt			pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	13.9	11.9	11.9	21.9	14.9		52.6	42.0		53.6	42.5	42.5
Effective Green, g (s)	13.9	11.9	11.9	21.9	14.9		52.6	42.0		53.6	42.5	42.5
Actuated g/C Ratio	0.15	0.13	0.13	0.24	0.17		0.58	0.47		0.60	0.47	0.47
Clearance Time (s)	5.0	5.0	5.0	2.5	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	122	244	209	329	266		332	1685		301	1742	720
v/s Ratio Prot	0.02	0.02		c0.07	0.11		0.09	c0.49		c0.11	0.31	
v/s Ratio Perm	0.10		0.04	c0.14			0.34			0.41		0.03
v/c Ratio	0.78	0.14	0.32	0.89	0.65		0.73	1.04		0.87	0.65	0.07
Uniform Delay, d1	38.1	34.5	35.4	32.4	35.1		12.8	24.0		24.8	18.1	13.0
Progression Factor	1.01	1.01	1.03	1.00	1.00		1.27	0.75		1.23	0.75	0.93
Incremental Delay, d2	26.2	0.3	0.9	24.5	5.3		5.5	31.4		18.5	0.7	0.0
Delay (s)	64.8	35.2	37.4	56.9	40.4		21.8	49.3		49.1	14.4	12.0
Level of Service	E	D	D	E	D		C	D		D	B	B
Approach Delay (s)		43.9			47.9			46.0			20.2	
Approach LOS		D			D			D			C	

Intersection Summary			
HCM Average Control Delay	37.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.5
Intersection Capacity Utilization	99.6%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner No Action - (Improved) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
21: I-35 SB Ramps & Gardner Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	430	0	1180	20	720	0	0	1210	380
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)				5.0	5.0	2.5	2.5	5.0			5.0	
Lane Util. Factor				1.00	0.95	0.95	1.00	0.95			0.95	
Frt				1.00	0.85	0.85	1.00	1.00			0.96	
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1752	1475	1475	1641	3725			3557	
Flt Permitted				0.95	1.00	1.00	0.16	1.00			1.00	
Satd. Flow (perm)				1752	1475	1475	269	3725			3557	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	453	0	1242	21	758	0	0	1274	400
RTOR Reduction (vph)	0	0	0	0	344	13	0	0	0	0	30	0
Lane Group Flow (vph)	0	0	0	453	277	608	21	758	0	0	1644	0
Heavy Vehicles (%)	0%	0%	0%	3%	0%	4%	10%	2%	0%	0%	3%	3%
Turn Type				custom		custom	pm+pt					
Protected Phases				8	8	1	5	2			6	
Permitted Phases				8		8	2					
Actuated Green, G (s)				26.1	26.1	51.8	27.9	25.7			49.2	
Effective Green, g (s)				26.1	26.1	51.8	27.9	25.7			49.2	
Actuated g/C Ratio				0.29	0.29	0.58	0.31	0.29			0.55	
Clearance Time (s)				5.0	5.0	2.5	2.5	5.0			5.0	
Vehicle Extension (s)				3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)				508	428	890	117	1064			1944	
v/s Ratio Prot				c0.26	0.19	c0.20	0.00	0.20			c0.46	
v/s Ratio Perm						0.22	0.05					
v/c Ratio				0.89	0.65	0.68	0.18	0.71			0.85	
Uniform Delay, d1				30.6	27.9	13.4	39.5	28.8			17.2	
Progression Factor				1.00	1.00	1.00	0.45	0.70			0.91	
Incremental Delay, d2				17.7	3.3	2.2	0.5	2.8			3.5	
Delay (s)				48.2	31.3	15.5	18.4	23.1			19.1	
Level of Service				D	C	B	B	C			B	
Approach Delay (s)		0.0			30.0			23.0			19.1	
Approach LOS		A			C			C			B	

Intersection Summary			
HCM Average Control Delay	24.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	82.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
22: I-35 NB Ramps & Gardner Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	190	0	20	0	0	0	0	540	250	760	870	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0						5.0	5.0	5.0	5.0	
Lane Util. Factor		1.00						1.00	1.00	0.97	0.95	
Frt		0.99						1.00	0.85	1.00	1.00	
Flt Protected		0.96						1.00	1.00	0.95	1.00	
Satd. Flow (prot)		1709						1961	1568	3367	3725	
Flt Permitted		0.96						1.00	1.00	0.95	1.00	
Satd. Flow (perm)		1709						1961	1568	3367	3725	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	200	0	21	0	0	0	0	568	263	800	916	0
RTOR Reduction (vph)	0	4	0	0	0	0	0	0	158	0	0	0
Lane Group Flow (vph)	0	217	0	0	0	0	0	568	105	800	916	0
Heavy Vehicles (%)	5%	0%	5%	0%	0%	0%	0%	2%	3%	4%	2%	0%
Turn Type	Split								Perm	Prot		
Protected Phases	4	4						2		1	6	
Permitted Phases									2			
Actuated Green, G (s)		14.8						35.8	35.8	24.4	65.2	
Effective Green, g (s)		14.8						35.8	35.8	24.4	65.2	
Actuated g/C Ratio		0.16						0.40	0.40	0.27	0.72	
Clearance Time (s)		5.0						5.0	5.0	5.0	5.0	
Vehicle Extension (s)		3.0						3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)		281						780	624	913	2699	
v/s Ratio Prot		c0.13						c0.29		c0.24	0.25	
v/s Ratio Perm									0.07			
v/c Ratio		0.77						0.73	0.17	0.88	0.34	
Uniform Delay, d1		36.0						23.0	17.5	31.4	4.5	
Progression Factor		1.00						0.87	1.02	0.80	0.99	
Incremental Delay, d2		12.3						5.3	0.5	5.3	0.2	
Delay (s)		48.3						25.2	18.3	30.5	4.7	
Level of Service		D						C	B	C	A	
Approach Delay (s)		48.3			0.0			23.1			16.7	
Approach LOS		D			A			C			B	

Intersection Summary			
HCM Average Control Delay	21.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	82.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
23: E 191st Street & Gardner Rd — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	30	140	650	20	70	810
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		5.0			5.0
Lane Util. Factor	1.00		1.00			1.00
Frt	0.89		1.00			1.00
Flt Protected	0.99		1.00			1.00
Satd. Flow (prot)	1613		1856			1850
Flt Permitted	0.99		1.00			0.90
Satd. Flow (perm)	1613		1856			1672
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	32	147	684	21	74	853
RTOR Reduction (vph)	133	0	1	0	0	0
Lane Group Flow (vph)	46	0	704	0	0	927
Heavy Vehicles (%)	3%	4%	2%	0%	6%	2%
Turn Type					Perm	
Protected Phases	8		2			6
Permitted Phases					6	
Actuated Green, G (s)	8.4		71.6			71.6
Effective Green, g (s)	8.4		71.6			71.6
Actuated g/C Ratio	0.09		0.80			0.80
Clearance Time (s)	5.0		5.0			5.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	151		1477			1330
v/s Ratio Prot	c0.03		0.38			
v/s Ratio Perm						c0.55
v/c Ratio	0.30		0.48			0.70
Uniform Delay, d1	38.1		3.0			4.2
Progression Factor	1.00		0.91			1.40
Incremental Delay, d2	1.1		0.2			2.9
Delay (s)	39.2		3.0			8.8
Level of Service	D		A			A
Approach Delay (s)	39.2		3.0			8.8
Approach LOS	D		A			A

Intersection Summary			
HCM Average Control Delay	9.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	104.7%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)
24: Sunflower Road & US 56 — PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	50	10	360	20	5	10	120	280	5	180	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.98			1.00			0.91			1.00	
Flt Protected		1.00			0.96			1.00			1.00	
Satd. Flow (prot)		1826			1779			1650			1805	
Flt Permitted		1.00			0.69			0.99			0.99	
Satd. Flow (perm)		1826			1291			1640			1792	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	53	11	379	21	5	11	126	295	5	189	5
RTOR Reduction (vph)	0	7	0	0	1	0	0	71	0	0	1	0
Lane Group Flow (vph)	0	57	0	0	404	0	0	361	0	0	198	0
Heavy Vehicles (%)	0%	2%	0%	2%	0%	0%	0%	8%	3%	0%	5%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		34.3			34.3			45.7			45.7	
Effective Green, g (s)		34.3			34.3			45.7			45.7	
Actuated g/C Ratio		0.38			0.38			0.51			0.51	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		696			492			833			910	
v/s Ratio Prot		0.03										
v/s Ratio Perm					c0.31			c0.22			0.11	
v/c Ratio		0.08			0.82			0.43			0.22	
Uniform Delay, d1		17.8			25.1			14.0			12.3	
Progression Factor		1.00			1.05			0.67			0.58	
Incremental Delay, d2		0.1			7.8			1.5			0.5	
Delay (s)		17.8			34.1			11.0			7.6	
Level of Service		B			C			B			A	
Approach Delay (s)		17.8			34.1			11.0			7.6	
Approach LOS		B			C			B			A	

Intersection Summary			
HCM Average Control Delay	19.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner No Action - (Improved) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)

25: US 56 & 4th Street

PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	330	130	90	460	150	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0	4.0	
Lane Util. Factor	1.00			1.00	1.00	
Frt	0.96			1.00	0.95	
Flt Protected	1.00			0.99	0.97	
Satd. Flow (prot)	1755			1833	1713	
Flt Permitted	1.00			0.86	0.97	
Satd. Flow (perm)	1755			1583	1713	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	347	137	95	484	158	84
RTOR Reduction (vph)	12	0	0	0	24	0
Lane Group Flow (vph)	472	0	0	579	218	0
Heavy Vehicles (%)	5%	2%	2%	3%	2%	3%
Turn Type			Perm			
Protected Phases	4			8	2	
Permitted Phases			8			
Actuated Green, G (s)	65.4			65.4	16.6	
Effective Green, g (s)	65.4			65.4	16.6	
Actuated g/C Ratio	0.73			0.73	0.18	
Clearance Time (s)	4.0			4.0	4.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	1275			1150	316	
v/s Ratio Prot	0.27				c0.13	
v/s Ratio Perm				c0.37		
v/c Ratio	0.37			0.50	0.69	
Uniform Delay, d1	4.6			5.3	34.3	
Progression Factor	1.00			0.67	1.00	
Incremental Delay, d2	0.8			1.4	6.4	
Delay (s)	5.4			4.9	40.7	
Level of Service	A			A	D	
Approach Delay (s)	5.4			4.9	40.7	
Approach LOS	A			A	D	

Intersection Summary			
HCM Average Control Delay	11.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	77.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)

26: 199th Street & Four Corners Road

PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	340	400	90	100	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	11	358	421	95	105	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	516				847	468
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	516				847	468
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				68	98
cM capacity (veh/h)	1060				329	599

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	368	516	116
Volume Left	11	0	105
Volume Right	0	95	11
cSH	1060	1700	343
Volume to Capacity	0.01	0.30	0.34
Queue Length 95th (ft)	1	0	36
Control Delay (s)	0.3	0.0	20.8
Lane LOS	A		C
Approach Delay (s)	0.3	0.0	20.8
Approach LOS			C

Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	39.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)

27: 199th Street & Gardner Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	170	20	30	260	290	20	120	30	420	200	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00		1.00		1.00	1.00	1.00
Frt	1.00	0.98		1.00	1.00	0.85		0.98		1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.99		0.95	1.00	1.00
Satd. Flow (prot)	1805	1837		1752	1863	1583		1796		1770	1863	1583
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.95		0.53	1.00	1.00
Satd. Flow (perm)	1805	1837		1752	1863	1583		1722		996	1863	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	179	21	32	274	305	21	126	32	442	211	53
RTOR Reduction (vph)	0	5	0	0	0	238	0	7	0	0	0	22
Lane Group Flow (vph)	21	195	0	32	274	67	0	172	0	442	211	31
Heavy Vehicles (%)	0%	2%	0%	3%	2%	2%	0%	3%	3%	2%	2%	2%
Turn Type	Prot			Prot		Perm	Perm			pm+pt		Perm
Protected Phases	5	2		1	6			8		7	4	
Permitted Phases						6	8			4		4
Actuated Green, G (s)	2.4	18.1		4.1	19.8	19.8		30.6		52.8	52.8	52.8
Effective Green, g (s)	2.4	18.1		4.1	19.8	19.8		30.6		52.8	52.8	52.8
Actuated g/C Ratio	0.03	0.20		0.05	0.22	0.22		0.34		0.59	0.59	0.59
Clearance Time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	48	369		80	410	348		585		732	1093	929
v/s Ratio Prot	0.01	c0.11		0.02	c0.15					c0.12	0.11	
v/s Ratio Perm						0.04		0.10		c0.24		0.02
v/c Ratio	0.44	0.53		0.40	0.67	0.19		0.29		0.60	0.19	0.03
Uniform Delay, d1	43.1	32.1		41.8	32.1	28.6		21.8		11.1	8.7	7.8
Progression Factor	0.96	0.92		1.00	1.00	1.00		1.00		0.77	0.68	0.76
Incremental Delay, d2	6.3	1.4		3.3	4.1	0.3		1.3		1.0	0.3	0.0
Delay (s)	47.7	30.8		45.0	36.2	28.9		23.0		9.5	6.2	6.0
Level of Service	D	C		D	D	C		C		A	A	A
Approach Delay (s)		32.4			33.0			23.0			8.2	
Approach LOS		C			C			C			A	

Intersection Summary			
HCM Average Control Delay	21.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	66.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner No-Action - (Improved)

30: US-56 & I-35 NB Loop

PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	1530	1350	0	1900	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	1611	1421	0	2000	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked					0.61	
vC, conflicting volume			3032		2611	805
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			3032		2365	805
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			114		19	330

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	805	805	1421	1000	1000
Volume Left	0	0	0	0	0
Volume Right	0	0	1421	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.47	0.47	0.84	0.59	0.59
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	86.9%	ICU Level of Service	E
Analysis Period (min)	15		

BNSF NEPA Traffic Study
37: 199th Street & West Waverley

2030 Gardner No-Action - (Improved)
PM Peak Hour

Movement	EBL	EBT	WBU	WBT	WBR	SBL	SBR
Lane Configurations							
Volume (veh/h)	0	720	0	770	10	90	0
Sign Control		Free		Free		Stop	
Grade		0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	783	0	837	11	98	0
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type		TWLTL		TWLTL			
Median storage veh)		2		2			
Upstream signal (ft)				802			
pX, platoon unblocked			0.00				
vC, conflicting volume	848		0			1625	842
vC1, stage 1 conf vol						842	
vC2, stage 2 conf vol						783	
vCu, unblocked vol	848		0			1625	842
tC, single (s)	4.1		0.0			6.4	6.2
tC, 2 stage (s)						5.4	
tF (s)	2.2		0.0			3.5	3.3
p0 queue free %	100		0			69	100
cM capacity (veh/h)	798		0			320	367

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	0	783	848	0	98
Volume Left	0	0	0	0	98
Volume Right	0	0	11	0	0
cSH	1700	1700	1700	1700	320
Volume to Capacity	0.00	0.46	0.50	0.00	0.31
Queue Length 95th (ft)	0	0	0	0	32
Control Delay (s)	0.0	0.0	0.0	0.0	21.1
Lane LOS					C
Approach Delay (s)	0.0		0.0		21.1
Approach LOS					C

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	52.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study
38: 199th Street & IH-35 SB Ramp

2030 Gardner No-Action - (Improved)
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	600	210	140	190	0	0	0	0	10	0	600
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		2.5		2.5	2.5					2.5		2.5
Lane Util. Factor		1.00		1.00	1.00					1.00		1.00
Frt		0.97		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		1798		1770	1863					1805		1583
Flt Permitted		1.00		0.22	1.00					0.95		1.00
Satd. Flow (perm)		1798		410	1863					1805		1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	652	228	152	207	0	0	0	0	11	0	652
RTOR Reduction (vph)	0	8	0	0	0	0	0	0	0	0	0	598
Lane Group Flow (vph)	0	872	0	152	207	0	0	0	0	11	0	54
Heavy Vehicles (%)	0%	2%	2%	2%	2%	0%	0%	0%	0%	0%	0%	2%
Turn Type				pm+pt						Prot		custom
Protected Phases		4		3	8					6		
Permitted Phases				8								6
Actuated Green, G (s)		65.4		77.5	77.5					7.5		7.5
Effective Green, g (s)		65.4		77.5	77.5					7.5		7.5
Actuated g/C Ratio		0.73		0.86	0.86					0.08		0.08
Clearance Time (s)		2.5		2.5	2.5					2.5		2.5
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		1307		498	1604					150		132
v/s Ratio Prot		c0.48		c0.03	0.11					0.01		
v/s Ratio Perm				0.23								c0.03
v/c Ratio		0.67		0.31	0.13					0.07		0.41
Uniform Delay, d1		6.5		5.0	1.0					38.0		39.2
Progression Factor		0.95		6.48	0.11					1.00		1.00
Incremental Delay, d2		2.7		0.3	0.0					0.2		2.1
Delay (s)		8.9		32.8	0.1					38.3		41.2
Level of Service		A		C	A					D		D
Approach Delay (s)		8.9			14.0			0.0			41.2	
Approach LOS		A			B			A			D	

Intersection Summary			
HCM Average Control Delay	21.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	7.5
Intersection Capacity Utilization	65.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
39: 199th Street & IH-35 NB Ramp

2030 Gardner No-Action - (Improved)
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	500	120	0	0	280	20	50	0	50	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0		5.0			
Lane Util. Factor	1.00	1.00			1.00		1.00		1.00			
Frt	1.00	1.00			0.99		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1770	1863			1848		1770		1583			
Flt Permitted	0.46	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	852	1863			1848		1770		1583			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	543	130	0	0	304	22	54	0	54	0	0	0
RTOR Reduction (vph)	0	0	0	0	2	0	0	0	50	0	0	0
Lane Group Flow (vph)	543	130	0	0	324	0	54	0	4	0	0	0
Heavy Vehicles (%)	2%	2%	0%	0%	2%	0%	2%	0%	2%	0%	0%	0%
Turn Type	pm+pt						custom		custom			
Protected Phases	7	4			8							
Permitted Phases	4						2		2			
Actuated Green, G (s)	72.9	72.9			34.1		7.1		7.1			
Effective Green, g (s)	72.9	72.9			34.1		7.1		7.1			
Actuated g/C Ratio	0.81	0.81			0.38		0.08		0.08			
Clearance Time (s)	5.0	5.0			5.0		5.0		5.0			
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Lane Grp Cap (vph)	1035	1509			700		140		125			
v/s Ratio Prot	c0.20	0.07			0.18							
v/s Ratio Perm	c0.23						c0.03		0.00			
v/c Ratio	0.52	0.09			0.46		0.39		0.03			
Uniform Delay, d1	6.9	1.7			21.0		39.4		38.3			
Progression Factor	0.41	0.31			0.33		1.00		1.00			
Incremental Delay, d2	0.4	0.1			0.4		1.8		0.1			
Delay (s)	3.2	0.6			7.3		41.1		38.4			
Level of Service	A	A			A		D		D			
Approach Delay (s)		2.7			7.3			39.8			0.0	
Approach LOS		A			A			D			A	

Intersection Summary			
HCM Average Control Delay	7.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	65.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
40: 199th Street & East Waverley

2030 Gardner No-Action - (Improved)
PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	160	10	5	290	10	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	174	11	5	315	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	820					
pX, platoon unblocked						
vC, conflicting volume			185		505	179
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			185		505	179
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	99
cM capacity (veh/h)			1402		528	869

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	185	321	16
Volume Left	0	5	11
Volume Right	11	0	5
cSH	1700	1402	607
Volume to Capacity	0.11	0.00	0.03
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.2	11.1
Lane LOS		A	B
Approach Delay (s)	0.0	0.2	11.1
Approach LOS			B

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	29.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

1: 175th Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Volume (vph)	70	20	640	10	10	10	380	250	10	20	220	50
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.92		1.00	0.99		1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1736	1677		1805	1850		1770	3521		1805	3389	
Flt Permitted	0.74	1.00		0.23	1.00		0.58	1.00		0.58	1.00	
Satd. Flow (perm)	1357	1677		442	1850		1075	3521		1108	3389	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	21	674	11	11	11	400	263	11	21	232	53
RTOR Reduction (vph)	0	485	0	0	9	0	0	2	0	0	14	0
Lane Group Flow (vph)	74	210	0	11	13	0	400	272	0	21	271	0
Heavy Vehicles (%)	4%	0%	2%	0%	0%	0%	2%	2%	0%	0%	3%	6%
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	17.2	17.2		17.2	17.2		62.8	52.8		51.6	46.6	
Effective Green, g (s)	17.2	17.2		17.2	17.2		62.8	52.8		51.6	46.6	
Actuated g/C Ratio	0.19	0.19		0.19	0.19		0.70	0.59		0.57	0.52	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	259	320		84	354		837	2066		674	1755	
v/s Ratio Prot		c0.13			0.01		c0.06	0.08		0.00	0.08	
v/s Ratio Perm	0.05			0.02			c0.27			0.02		
v/c Ratio	0.29	0.66		0.13	0.04		0.48	0.13		0.03	0.15	
Uniform Delay, d1	31.1	33.7		30.2	29.7		6.5	8.3		8.4	11.4	
Progression Factor	1.00	1.00		1.00	1.00		0.80	0.42		1.00	1.00	
Incremental Delay, d2	0.6	4.8		0.7	0.0		0.4	0.1		0.0	0.2	
Delay (s)	31.8	38.4		30.9	29.7		5.7	3.6		8.4	11.6	
Level of Service	C	D		C	C		A	A		A	B	
Approach Delay (s)		37.8			30.1			4.8			11.3	
Approach LOS		D			C			A			B	

Intersection Summary			
HCM Average Control Delay	20.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	79.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

2: US 56 & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↑	↱	↰	↑↑	↱	↰↰	↑↱	
Volume (vph)	140	830	60	180	420	250	70	1000	310	380	830	150
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1752	3619	1583	1687	3519	1553	1752	3689	1553	3400	3435	
Flt Permitted	0.43	1.00	1.00	0.16	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	792	3619	1583	282	3519	1553	1752	3689	1553	3400	3435	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	147	874	63	189	442	263	74	1053	326	400	874	158
RTOR Reduction (vph)	0	0	39	0	0	189	0	0	117	0	16	0
Lane Group Flow (vph)	147	874	24	189	442	74	74	1053	209	400	1016	0
Heavy Vehicles (%)	3%	5%	2%	7%	8%	4%	3%	3%	4%	3%	3%	1%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			
Actuated Green, G (s)	31.4	24.8	24.8	32.2	25.2	25.2	5.9	29.7	29.7	11.8	35.6	
Effective Green, g (s)	31.4	24.8	24.8	32.2	25.2	25.2	5.9	29.7	29.7	11.8	35.6	
Actuated g/C Ratio	0.35	0.28	0.28	0.36	0.28	0.28	0.07	0.33	0.33	0.13	0.40	
Clearance Time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	347	997	436	210	985	435	115	1217	512	446	1359	
v/s Ratio Prot	0.03	0.24		c0.07	0.13		0.04	c0.29		c0.12	0.30	
v/s Ratio Perm	0.12		0.02	c0.25		0.05			0.13			
v/c Ratio	0.42	0.88	0.05	0.90	0.45	0.17	0.64	0.87	0.41	0.90	0.75	
Uniform Delay, d1	20.9	31.1	24.0	23.5	26.7	24.5	41.0	28.3	23.3	38.5	23.3	
Progression Factor	0.61	0.70	0.57	1.35	1.05	2.65	0.73	0.58	0.24	1.00	1.00	
Incremental Delay, d2	0.8	10.1	0.2	34.7	1.4	0.8	8.1	4.6	0.4	20.2	2.3	
Delay (s)	13.6	31.9	13.9	66.5	29.5	65.7	38.2	21.1	5.9	58.7	25.6	
Level of Service	B	C	B	E	C	E	D	C	A	E	C	
Approach Delay (s)		28.4			48.0			18.6			34.9	
Approach LOS		C			D			B			C	

Intersection Summary			
HCM Average Control Delay	31.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	13.3
Intersection Capacity Utilization	85.3%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

3: US 56 & Elm

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱			↰↑↱		↰	↱		↰	↱	
Volume (vph)	20	1510	10	10	800	90	10	10	30	110	10	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			0.98		1.00	0.89		1.00	0.88	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3436			3339		1805	1651		1770	1610	
Flt Permitted		0.94			0.93		0.72	1.00		0.73	1.00	
Satd. Flow (perm)		3215			3101		1373	1651		1358	1610	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	1589	11	11	842	95	11	11	32	116	11	42
RTOR Reduction (vph)	0	0	0	0	6	0	0	28	0	0	37	0
Lane Group Flow (vph)	0	1621	0	0	942	0	11	15	0	116	16	0
Heavy Vehicles (%)	0%	5%	0%	0%	7%	2%	0%	0%	3%	2%	0%	5%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		69.5			69.5		11.5	11.5		11.5	11.5	
Effective Green, g (s)		69.5			69.5		11.5	11.5		11.5	11.5	
Actuated g/C Ratio		0.77			0.77		0.13	0.13		0.13	0.13	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2483			2395		175	211		174	206	
v/s Ratio Prot								0.01			0.01	
v/s Ratio Perm		c0.50			0.30		0.01			c0.09		
v/c Ratio		0.65			0.39		0.06	0.07		0.67	0.08	
Uniform Delay, d1		4.7			3.4		34.5	34.6		37.4	34.6	
Progression Factor		0.69			0.98		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.8			0.5		0.2	0.1		9.3	0.2	
Delay (s)		4.1			3.7		34.7	34.7		46.7	34.8	
Level of Service		A			A		C	C		D	C	
Approach Delay (s)		4.1			3.7			34.7			43.0	
Approach LOS		A			A			C			D	

Intersection Summary			
HCM Average Control Delay	6.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	76.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

4: US 56 & Mulberry

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱			↰↑↱		↰	↱		↰	↱	
Volume (vph)	40	1670	10	10	850	60	5	5	20	100	5	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			0.99		1.00	0.88		1.00	0.87	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3464			3339		1805	1548		1770	1612	
Flt Permitted		0.90			0.92		0.73	1.00		0.74	1.00	
Satd. Flow (perm)		3135			3085		1393	1548		1379	1612	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	42	1758	11	11	895	63	5	5	21	105	5	32
RTOR Reduction (vph)	0	0	0	0	5	0	0	19	0	0	28	0
Lane Group Flow (vph)	0	1811	0	0	964	0	5	7	0	105	9	0
Heavy Vehicles (%)	5%	4%	0%	0%	7%	8%	0%	20%	5%	2%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		71.0			71.0		10.0	10.0		10.0	10.0	
Effective Green, g (s)		71.0			71.0		10.0	10.0		10.0	10.0	
Actuated g/C Ratio		0.79			0.79		0.11	0.11		0.11	0.11	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2473			2434		155	172		153	179	
v/s Ratio Prot								0.00			0.01	
v/s Ratio Perm		c0.58			0.31		0.00			c0.08		
v/c Ratio		0.73			0.40		0.03	0.04		0.69	0.05	
Uniform Delay, d1		4.7			2.9		35.7	35.7		38.5	35.7	
Progression Factor		0.33			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.6			0.1		0.1	0.1		12.0	0.1	
Delay (s)		3.2			3.0		35.8	35.8		50.5	35.9	
Level of Service		A			A		D	D		D	D	
Approach Delay (s)		3.2			3.0			35.8			46.7	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	5.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	94.9%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner IMF Operations - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

5: US 56 & Moonlight Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	180	1430	200	150	690	590	140	620	270	1160	530	110
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1719	3654	1568	1770	3519	1583	1770	3725	1553	3433	3539	1553
Flt Permitted	0.21	1.00	1.00	0.10	1.00	1.00	0.44	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	386	3654	1568	188	3519	1583	825	3725	1553	3433	3539	1553
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	189	1505	211	158	726	621	147	653	284	1221	558	116
RTOR Reduction (vph)	0	0	56	0	0	340	0	0	81	0	0	79
Lane Group Flow (vph)	189	1505	155	158	726	281	147	653	203	1221	558	37
Heavy Vehicles (%)	5%	4%	3%	2%	2%	8%	2%	2%	4%	2%	2%	4%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		custom	Prot		Perm
Protected Phases	5	2		1	6		3	8	8	7	4	
Permitted Phases	2		2	6		6	8		8			4
Actuated Green, G (s)	52.4	43.0	43.0	45.6	39.6	39.6	26.7	16.5	16.5	31.5	37.8	37.8
Effective Green, g (s)	52.4	43.0	43.0	45.6	39.6	39.6	26.7	16.5	16.5	31.5	37.8	37.8
Actuated g/C Ratio	0.44	0.36	0.36	0.38	0.33	0.33	0.22	0.14	0.14	0.26	0.32	0.32
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	273	1309	562	151	1161	522	264	512	214	901	1115	489
v/s Ratio Prot	0.05	c0.41		c0.05	0.21		0.05	c0.18	0.13	c0.36	0.16	
v/s Ratio Perm	0.25		0.10	0.35		0.18	0.08					0.02
v/c Ratio	0.69	1.15	0.28	1.05	0.63	0.54	0.56	1.28	0.95	1.36	0.50	0.07
Uniform Delay, d1	23.4	38.5	27.4	34.2	33.9	32.7	39.6	51.8	51.3	44.2	33.4	28.8
Progression Factor	1.00	1.00	1.00	1.14	0.89	1.12	0.84	1.04	1.04	1.00	1.00	1.00
Incremental Delay, d2	6.0	76.7	1.2	82.7	2.3	3.6	1.2	136.4	41.6	167.1	0.1	0.0
Delay (s)	29.4	115.2	28.6	121.9	32.5	40.2	34.4	190.0	94.8	211.4	33.6	28.9
Level of Service	C	F	C	F	C	D	C	F	F	F	C	C
Approach Delay (s)		97.1			45.1			144.0			147.8	
Approach LOS		F			D			F			F	

Intersection Summary			
HCM Average Control Delay	107.8	HCM Level of Service	F
HCM Volume to Capacity ratio	1.23		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	114.4%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

6: Old US 56 & US 56 — AM Peak Hour

Movement	NBL	NBR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	150	10	1870	1000	10	1300
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	0.97	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	3433	1615	3654	1583	1805	3585
Flt Permitted	0.95	1.00	1.00	1.00	0.06	1.00
Satd. Flow (perm)	3433	1615	3654	1583	119	3585
Peak-hour factor, PHF	0.97	0.97	0.95	0.95	0.95	0.95
Adj. Flow (vph)	155	10	1968	1053	11	1368
RTOR Reduction (vph)	0	9	0	123	0	0
Lane Group Flow (vph)	155	1	1968	930	11	1368
Heavy Vehicles (%)	2%	0%	4%	2%	0%	6%
Turn Type		Perm		pm+ov	pm+pt	
Protected Phases	8		2	8	1	6
Permitted Phases		8	2	2	6	6
Actuated Green, G (s)	13.1	13.1	90.7	103.8	96.9	96.9
Effective Green, g (s)	13.1	13.1	90.7	103.8	96.9	96.9
Actuated g/C Ratio	0.11	0.11	0.76	0.86	0.81	0.81
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	375	176	2762	1435	113	2895
v/s Ratio Prot	0.05		c0.54	c0.07	0.00	c0.38
v/s Ratio Perm		0.00		0.52	0.08	
v/c Ratio	0.41	0.01	0.71	0.65	0.10	0.47
Uniform Delay, d1	49.9	47.6	7.8	2.5	9.2	3.6
Progression Factor	1.00	1.00	0.75	15.44	1.25	1.20
Incremental Delay, d2	0.7	0.0	0.1	0.1	0.2	0.1
Delay (s)	50.6	47.7	5.9	38.5	11.7	4.4
Level of Service	D	D	A	D	B	A
Approach Delay (s)	50.4		17.3			4.5
Approach LOS	D		B			A

Intersection Summary			
HCM Average Control Delay	14.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	73.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

7: US-56 & Cedar Niles — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	2050	160	670	2100	100	130	30	760	60	20	70
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2	5.2	5.2	5.2	5.2
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00	1.00	1.00	0.88	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1787	3725	1583	3433	3689	1583	1770	1942	2787	1752	2000	1553
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.74	1.00	1.00	0.74	1.00	1.00
Satd. Flow (perm)	1787	3725	1583	3433	3689	1583	1385	1942	2787	1358	2000	1553
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	2158	168	705	2211	105	137	32	800	63	21	74
RTOR Reduction (vph)	0	0	67	0	0	28	0	0	0	0	0	65
Lane Group Flow (vph)	74	2158	101	705	2211	77	137	32	800	63	21	9
Heavy Vehicles (%)	1%	2%	2%	2%	3%	2%	2%	3%	2%	3%	0%	4%
Turn Type	Prot		Perm	Prot		Perm	Perm		pt+ov	Perm		Perm
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases			2			6	8			4		4
Actuated Green, G (s)	5.6	68.8	68.8	23.0	86.2	86.2	12.6	12.6	40.8	12.6	12.6	12.6
Effective Green, g (s)	5.6	68.8	68.8	23.0	86.2	86.2	12.6	12.6	40.8	12.6	12.6	12.6
Actuated g/C Ratio	0.05	0.57	0.57	0.19	0.72	0.72	0.10	0.10	0.34	0.10	0.10	0.10
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2		5.2	5.2	5.2
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lane Grp Cap (vph)	83	2136	908	658	2650	1137	145	204	948	143	210	163
v/s Ratio Prot	0.04	c0.58		c0.21	0.60			0.02	c0.29		0.01	
v/s Ratio Perm			0.06			0.05	0.10			0.05		0.01
v/c Ratio	0.89	1.01	0.11	1.07	0.83	0.07	0.94	0.16	0.84	0.44	0.10	0.05
Uniform Delay, d1	56.9	25.6	11.7	48.5	11.9	5.0	53.4	48.9	36.7	50.4	48.6	48.3
Progression Factor	0.87	0.76	0.40	1.07	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	55.8	20.4	0.2	40.3	0.8	0.0	57.3	0.1	6.7	0.8	0.1	0.0
Delay (s)	105.1	39.8	4.9	92.2	12.7	5.0	110.7	49.0	43.3	51.2	48.6	48.4
Level of Service	F	D	A	F	B	A	F	D	D	D	D	D
Approach Delay (s)		39.3			31.0			53.0			49.5	
Approach LOS		D			C			D			D	

Intersection Summary			
HCM Average Control Delay	37.7	HCM Level of Service	D
HCM Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.6
Intersection Capacity Utilization	102.8%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

8: US-56 & I-35 SB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	2750	90	330	1450	0	0	0	0	210	0	1370
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		1.00		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3509		1719	3725					1736		2760
Flt Permitted		1.00		0.11	1.00					0.95		1.00
Satd. Flow (perm)		3509		203	3725					1736		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2895	95	347	1526	0	0	0	0	221	0	1442
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	8
Lane Group Flow (vph)	0	2988	0	347	1526	0	0	0	0	221	0	1434
Heavy Vehicles (%)	0%	2%	14%	5%	2%	0%	0%	0%	0%	4%	0%	3%
Turn Type				pm+pt						custom		custom
Protected Phases		2		1	6					4		5
Permitted Phases				6						4		4
Actuated Green, G (s)		77.0		51.6	51.6					12.0		53.4
Effective Green, g (s)		77.0		51.6	51.6					12.0		53.4
Actuated g/C Ratio		0.64		0.43	0.43					0.10		0.44
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2252		289	1602					174		1343
v/s Ratio Prot		c0.85		c0.16	0.41					0.13		c0.37
v/s Ratio Perm				0.36								0.15
v/c Ratio		1.33		1.20	0.95					1.27		1.07
Uniform Delay, d1		21.5		35.6	33.0					54.0		33.3
Progression Factor		0.72		0.91	0.88					1.00		1.00
Incremental Delay, d2		148.1		110.7	9.6					158.8		44.8
Delay (s)		163.5		143.0	38.7					212.8		78.1
Level of Service		F		F	D					F		E
Approach Delay (s)		163.5			58.0			0.0			96.0	
Approach LOS		F			E			A			F	

Intersection Summary			
HCM Average Control Delay	116.0	HCM Level of Service	F
HCM Volume to Capacity ratio	1.25		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	120.5%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

9: US-56 & I-35 NB Ramps

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1320	0	0	1610	510	170	0	700	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95	0.95			
Frt		1.00			1.00	0.85	1.00	0.85	0.85			
Flt Protected		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (prot)		3725			3539	1583	1687	1475	1475			
Flt Permitted		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (perm)		3725			3539	1583	1687	1475	1475			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1389	0	0	1695	537	179	0	737	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	110	0	0	0	0	0	0
Lane Group Flow (vph)	0	1389	0	0	1695	427	179	369	368	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	2%	7%	0%	4%	0%	0%	0%
Turn Type						Perm	Perm		Perm			
Protected Phases		2			6			8				
Permitted Phases						6	8		8			
Actuated Green, G (s)		74.6			74.6	74.6	35.4	35.4	35.4			
Effective Green, g (s)		74.6			74.6	74.6	35.4	35.4	35.4			
Actuated g/C Ratio		0.62			0.62	0.62	0.30	0.30	0.30			
Clearance Time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0	3.0			
Lane Grp Cap (vph)		2316			2200	984	498	435	435			
v/s Ratio Prot		0.37			c0.48			c0.25				
v/s Ratio Perm						0.27	0.11		0.25			
v/c Ratio		0.60			0.77	0.43	0.36	0.85	0.85			
Uniform Delay, d1		13.7			16.5	11.8	33.4	39.8	39.7			
Progression Factor		0.50			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2		0.1			1.7	0.3	0.4	14.2	14.1			
Delay (s)		6.9			18.2	12.1	33.8	54.0	53.8			
Level of Service		A			B	B	C	D	D			
Approach Delay (s)		6.9			16.7			50.0			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	20.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	104.3%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

10: Santa Fe & Moonlight Road

AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	120	320	710	240	460	410
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.96		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3380		1770	3505
Flt Permitted	0.95	1.00	1.00		0.21	1.00
Satd. Flow (perm)	1770	1583	3380		399	3505
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	126	337	747	253	484	432
RTOR Reduction (vph)	0	298	20	0	0	0
Lane Group Flow (vph)	126	39	980	0	484	432
Heavy Vehicles (%)	2%	2%	3%	2%	2%	3%
Turn Type		Perm			pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8			6	
Actuated Green, G (s)	13.8	13.8	65.1		96.2	96.2
Effective Green, g (s)	13.8	13.8	65.1		96.2	96.2
Actuated g/C Ratio	0.12	0.12	0.54		0.80	0.80
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	204	182	1834		618	2810
v/s Ratio Prot	c0.07		0.29		c0.17	0.12
v/s Ratio Perm		0.02			c0.46	
v/c Ratio	0.62	0.21	0.53		0.78	0.15
Uniform Delay, d1	50.6	48.2	17.7		18.5	2.7
Progression Factor	1.00	1.00	1.00		0.86	1.20
Incremental Delay, d2	5.5	0.6	1.1		5.4	0.1
Delay (s)	56.1	48.8	18.8		21.3	3.3
Level of Service	E	D	B		C	A
Approach Delay (s)	50.7		18.8			12.8
Approach LOS	D		B			B

Intersection Summary			
HCM Average Control Delay	22.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	71.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

11: Waverly Road & US 56

AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	20	250	120	560	250	40	70	140	20	90	70	310
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95		1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.98		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1805	3539	1538	3400	3458		1736	3312	1615	1752	2935	1568
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1805	3539	1538	3400	3458		1736	3312	1615	1752	2935	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	263	126	589	263	42	74	147	21	95	74	326
RTOR Reduction (vph)	0	0	109	0	15	0	0	0	16	0	0	230
Lane Group Flow (vph)	21	263	17	589	290	0	74	147	5	95	74	96
Heavy Vehicles (%)	0%	2%	5%	3%	1%	10%	4%	9%	0%	3%	23%	3%
Turn Type	Prot		Perm	Prot			Prot		Perm	Prot		Perm
Protected Phases	3	8		7	4		5	2		1	6	
Permitted Phases			8					2	2			6
Actuated Green, G (s)	3.1	12.1	12.1	23.7	32.7		7.8	22.7	22.7	11.5	26.4	26.4
Effective Green, g (s)	3.1	12.1	12.1	23.7	32.7		7.8	22.7	22.7	11.5	26.4	26.4
Actuated g/C Ratio	0.03	0.13	0.13	0.26	0.36		0.09	0.25	0.25	0.13	0.29	0.29
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	62	476	207	895	1256		150	835	407	224	861	460
v/s Ratio Prot	0.01	c0.07		c0.17	0.08		0.04	0.04		c0.05	0.03	
v/s Ratio Perm			0.01						0.00			c0.06
v/c Ratio	0.34	0.55	0.08	0.66	0.23		0.49	0.18	0.01	0.42	0.09	0.21
Uniform Delay, d1	42.4	36.4	34.1	29.5	19.9		39.2	26.3	25.2	36.2	23.1	23.9
Progression Factor	0.96	0.98	0.91	0.95	0.93		0.86	0.80	0.65	1.36	0.66	0.78
Incremental Delay, d2	3.2	1.4	0.2	1.5	0.1		2.3	0.4	0.1	1.1	0.2	0.9
Delay (s)	44.1	37.0	31.2	29.5	18.6		36.0	21.5	16.5	50.2	15.3	19.5
Level of Service	D	D	C	C	B		D	C	B	D	B	B
Approach Delay (s)		35.6			25.8			25.5			24.8	
Approach LOS		D			C			C			C	

Intersection Summary			
HCM Average Control Delay	27.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.46		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	48.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

12: 183rd Street & Four Corners Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	20	5	5	40	5	10	20	5	5	50	5
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	21	5	5	42	5	11	21	5	5	53	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	32	53	37	63
Volume Left (vph)	5	5	11	5
Volume Right (vph)	5	5	5	5
Hadj (s)	-0.07	0.00	0.02	0.02
Departure Headway (s)	4.1	4.2	4.2	4.1
Degree Utilization, x	0.04	0.06	0.04	0.07
Capacity (veh/h)	849	842	834	847
Control Delay (s)	7.3	7.4	7.4	7.5
Approach Delay (s)	7.3	7.4	7.4	7.5
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.4		
HCM Level of Service	A		
Intersection Capacity Utilization	14.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
13: 183rd Street & US 56 — AM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	30	0	0	200	80	40
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	32	0	0	211	84	42
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	316	105	126			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	316	105	126			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	95	100	100			
cM capacity (veh/h)	681	955	1473			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	32	211	126
Volume Left	32	0	0
Volume Right	0	0	42
cSH	681	1473	1700
Volume to Capacity	0.05	0.00	0.07
Queue Length 95th (ft)	4	0	0
Control Delay (s)	10.5	0.0	0.0
Lane LOS	B		
Approach Delay (s)	10.5	0.0	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	20.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
14: 183rd Street & Waverly Road — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	20	160	230	20	190	170
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	168	242	21	200	179
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	832	253			263	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	832	253			263	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	93	79			85	
cM capacity (veh/h)	290	791			1313	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	189	263	379
Volume Left	21	0	200
Volume Right	168	21	0
cSH	664	1700	1313
Volume to Capacity	0.29	0.15	0.15
Queue Length 95th (ft)	29	0	13
Control Delay (s)	12.6	0.0	5.0
Lane LOS	B		A
Approach Delay (s)	12.6	0.0	5.0
Approach LOS	B		

Intersection Summary			
Average Delay	5.1		
Intersection Capacity Utilization	53.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
15: 183rd Street & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	120	80	200	230	110	120	150	1070	210	100	930	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.89		1.00	0.92		1.00	0.98		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1658		1770	1717		1787	3424		1770	3483	
Flt Permitted	0.51	1.00		0.23	1.00		0.19	1.00		0.11	1.00	
Satd. Flow (perm)	949	1658		421	1717		362	3424		205	3483	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	126	84	211	242	116	126	158	1126	221	105	979	116
RTOR Reduction (vph)	0	103	0	0	0	0	0	17	0	0	10	0
Lane Group Flow (vph)	126	192	0	242	242	0	158	1330	0	105	1085	0
Heavy Vehicles (%)	2%	3%	2%	2%	2%	2%	1%	3%	2%	2%	2%	2%
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	19.7	13.7		27.7	17.7		42.4	42.4		40.3	40.3	
Effective Green, g (s)	19.7	13.7		27.7	17.7		42.4	42.4		40.3	40.3	
Actuated g/C Ratio	0.22	0.15		0.31	0.20		0.47	0.47		0.45	0.45	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	262	252		279	338		266	1613		160	1560	
v/s Ratio Prot	0.03	0.12		c0.10	0.14		0.04	c0.39		0.03	c0.31	
v/s Ratio Perm	0.07			c0.17			0.24			0.27		
v/c Ratio	0.48	0.76		0.87	0.72		0.59	0.82		0.66	0.70	
Uniform Delay, d1	29.6	36.6		26.2	33.8		26.8	20.6		20.3	19.9	
Progression Factor	1.20	1.15		1.00	1.00		0.77	0.72		0.68	0.81	
Incremental Delay, d2	1.4	12.6		23.5	7.0		2.5	3.5		6.9	1.9	
Delay (s)	36.8	54.5		49.7	40.8		23.3	18.3		20.7	18.0	
Level of Service	D	D		D	D		C	B		C	B	
Approach Delay (s)		49.2			45.3			18.8			18.3	
Approach LOS		D			D			B			B	

Intersection Summary			
HCM Average Control Delay	25.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	87.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
16: Four Corners Road & US 56 — AM Peak Hour

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	0	50	30	190	80	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	0	53	32	200	84	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	347	84	84			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	347	84	84			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	95	98			
cM capacity (veh/h)	640	975	1506			

Direction, Lane #	SB 1	NE 1	SW 1
Volume Total	53	232	84
Volume Left	0	32	0
Volume Right	53	0	0
cSH	975	1506	1700
Volume to Capacity	0.05	0.02	0.05
Queue Length 95th (ft)	4	2	0
Control Delay (s)	8.9	1.2	0.0
Lane LOS	A	A	
Approach Delay (s)	8.9	1.2	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	2.0		
Intersection Capacity Utilization	28.3%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner IMF Operations - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

17: 191st Street & US 56

AM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	20	5	5	200	70	60
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	5	5	211	74	63
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	326	105	137			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	326	105	137			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	99	100			
cM capacity (veh/h)	670	955	1460			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	26	216	137
Volume Left	21	5	0
Volume Right	5	0	63
cSH	712	1460	1700
Volume to Capacity	0.04	0.00	0.08
Queue Length 95th (ft)	3	0	0
Control Delay (s)	10.2	0.2	0.0
Lane LOS	B	A	
Approach Delay (s)	10.2	0.2	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	24.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

19: 191st Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	90	60	50	10	50	60	5	100	30	60	50	90
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	95	63	53	11	53	63	5	105	32	63	53	95
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	116			116			505	416	89	468	411	84
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	116			116			505	416	89	468	411	84
tC, single (s)	4.2			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.3			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	93			99			99	79	97	84	89	90
cM capacity (veh/h)	1430			1486			377	490	966	388	495	969

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	211	126	142	211
Volume Left	95	11	5	63
Volume Right	53	63	32	95
cSH	1430	1486	544	574
Volume to Capacity	0.07	0.01	0.26	0.37
Queue Length 95th (ft)	5	1	26	42
Control Delay (s)	3.8	0.7	13.9	14.9
Lane LOS	A	A	B	B
Approach Delay (s)	3.8	0.7	13.9	14.9
Approach LOS			B	B

Intersection Summary			
Average Delay	8.7		
Intersection Capacity Utilization	46.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

20: W 188th Street & Gardner Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	30	260	210	30	240	260	980	260	260	1250	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	5.0	5.0	5.0	2.5	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.87		1.00	0.97		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1787	1845	1583	1770	1613		1752	3524		1770	3689	1553
Flt Permitted	0.32	1.00	1.00	0.70	1.00		0.10	1.00		0.10	1.00	1.00
Satd. Flow (perm)	597	1845	1583	1308	1613		192	3524		190	3689	1553
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	84	33	274	228	33	261	274	1032	283	283	1316	95
RTOR Reduction (vph)	0	0	236	0	223	0	0	26	0	0	0	50
Lane Group Flow (vph)	84	33	38	228	71	0	274	1289	0	283	1316	45
Heavy Vehicles (%)	1%	3%	2%	2%	3%	2%	3%	5%	2%	2%	3%	4%
Turn Type	pm+pt		Perm	pm+pt			pm+pt			pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	16.8	12.6	12.6	20.5	13.2		51.8	38.4		53.4	39.2	39.2
Effective Green, g (s)	16.8	12.6	12.6	20.5	13.2		51.8	38.4		53.4	39.2	39.2
Actuated g/C Ratio	0.19	0.14	0.14	0.23	0.15		0.58	0.43		0.59	0.44	0.44
Clearance Time (s)	5.0	5.0	5.0	2.5	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	167	258	222	335	237		343	1504		362	1607	676
v/s Ratio Prot	0.02	0.02		c0.06	0.04		0.12	c0.37		c0.12	0.36	
v/s Ratio Perm	0.07		0.02	c0.10			0.34			0.34		0.03
v/c Ratio	0.50	0.13	0.17	0.68	0.30		0.80	0.86		0.78	0.82	0.07
Uniform Delay, d1	31.7	33.9	34.1	31.1	34.3		21.8	23.3		22.2	22.3	14.8
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.03	0.93		1.30	0.57	0.40
Incremental Delay, d2	2.4	0.2	0.4	5.6	0.7		10.9	5.8		8.5	2.7	0.0
Delay (s)	34.0	34.1	34.5	36.7	35.0		33.4	27.5		37.3	15.4	6.0
Level of Service	C	C	C	D	C		C	C		D	B	A
Approach Delay (s)		34.4			35.7			28.5			18.5	
Approach LOS		C			D			C			B	

Intersection Summary			
HCM Average Control Delay	25.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	85.5%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

21: I-35 SB Ramps & Gardner Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	210	0	660	10	830	0	0	1550	170
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)				5.0	5.0	2.5	2.5	5.0			5.0	
Lane Util. Factor				1.00	0.95	0.95	1.00	0.95			0.95	
Frt				1.00	0.85	0.85	1.00	1.00			0.99	
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1703	1434	1434	1805	3689			3663	
Flt Permitted				0.95	1.00	1.00	0.10	1.00			1.00	
Satd. Flow (perm)				1703	1434	1434	198	3689			3663	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	221	0	695	11	874	0	0	1632	179
RTOR Reduction (vph)	0	0	0	0	286	55	0	0	0	0	8	0
Lane Group Flow (vph)	0	0	0	221	62	292	11	874	0	0	1803	0
Heavy Vehicles (%)	0%	0%	0%	6%	0%	7%	0%	3%	0%	0%	2%	4%
Turn Type				custom		custom	pm+pt					
Protected Phases				8	8	1	5	2			6	
Permitted Phases				8		8	2					
Actuated Green, G (s)				16.0	16.0	38.1	39.4	39.4			60.4	
Effective Green, g (s)				16.0	16.0	38.1	39.4	39.4			60.4	
Actuated g/C Ratio				0.18	0.18	0.42	0.44	0.44			0.67	
Clearance Time (s)				5.0	5.0	2.5	2.5	5.0			5.0	
Vehicle Extension (s)				3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)				303	255	647	106	1615			2458	
v/s Ratio Prot				c0.13	0.04	0.11	0.00	c0.24			c0.49	
v/s Ratio Perm						0.09	0.04					
v/c Ratio				0.73	0.24	0.45	0.10	0.54			0.73	
Uniform Delay, d1				35.0	31.8	18.5	19.6	18.6			9.6	
Progression Factor				1.00	1.00	1.00	0.24	0.49			0.49	
Incremental Delay, d2				8.5	0.5	0.5	0.1	0.3			1.3	
Delay (s)				43.5	32.3	19.0	4.8	9.5			6.0	
Level of Service				D	C	B	A	A			A	
Approach Delay (s)		0.0			29.9			9.4			6.0	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM Average Control Delay	12.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	93.8%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
22: I-35 NB Ramps & Gardner Rd
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	370	0	40	0	0	0	0	480	450	1070	690	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0						5.0	5.0	5.0	5.0	
Lane Util. Factor		1.00						1.00	1.00	0.97	0.95	
Frt		0.99						1.00	0.85	1.00	1.00	
Flt Protected		0.96						1.00	1.00	0.95	1.00	
Satd. Flow (prot)		1754						1942	1583	3433	3725	
Flt Permitted		0.96						1.00	1.00	0.95	1.00	
Satd. Flow (perm)		1754						1942	1583	3433	3725	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	389	0	42	0	0	0	0	505	474	1126	726	0
RTOR Reduction (vph)	0	5	0	0	0	0	0	0	348	0	0	0
Lane Group Flow (vph)	0	426	0	0	0	0	0	505	126	1126	726	0
Heavy Vehicles (%)	2%	0%	5%	0%	0%	0%	0%	3%	2%	2%	2%	0%
Turn Type	Split								Perm	Prot		
Protected Phases	4	4						2		1	6	
Permitted Phases									2			
Actuated Green, G (s)		22.0						24.0	24.0	29.0	58.0	
Effective Green, g (s)		22.0						24.0	24.0	29.0	58.0	
Actuated g/C Ratio		0.24						0.27	0.27	0.32	0.64	
Clearance Time (s)		5.0						5.0	5.0	5.0	5.0	
Vehicle Extension (s)		3.0						3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)		429						518	422	1106	2401	
v/s Ratio Prot		c0.24						c0.26		c0.33	0.19	
v/s Ratio Perm									0.08			
v/c Ratio		0.99						0.97	0.30	1.02	0.30	
Uniform Delay, d1		33.9						32.7	26.3	30.5	7.1	
Progression Factor		1.00						0.87	0.99	0.86	0.51	
Incremental Delay, d2		41.7						30.4	1.5	27.3	0.2	
Delay (s)		75.6						58.8	27.5	53.6	3.8	
Level of Service		E						E	C	D	A	
Approach Delay (s)		75.6			0.0			43.6			34.1	
Approach LOS		E			A			D			C	

Intersection Summary			
HCM Average Control Delay	42.4	HCM Level of Service	D
HCM Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	93.8%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
23: E 191st Street & Gardner Rd
AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	20	80	850	20	100	640
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		5.0			5.0
Lane Util. Factor	1.00		1.00			1.00
Frt	0.89		1.00			1.00
Flt Protected	0.99		1.00			0.99
Satd. Flow (prot)	1639		1840			1843
Flt Permitted	0.99		1.00			0.77
Satd. Flow (perm)	1639		1840			1425
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	84	895	21	105	674
RTOR Reduction (vph)	78	0	1	0	0	0
Lane Group Flow (vph)	27	0	915	0	0	779
Heavy Vehicles (%)	0%	3%	3%	0%	5%	2%
Turn Type					Perm	
Protected Phases	8		2			6
Permitted Phases					6	
Actuated Green, G (s)	6.4		73.6			73.6
Effective Green, g (s)	6.4		73.6			73.6
Actuated g/C Ratio	0.07		0.82			0.82
Clearance Time (s)	5.0		5.0			5.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	117		1505			1165
v/s Ratio Prot	c0.02		0.50			
v/s Ratio Perm						c0.55
v/c Ratio	0.23		0.61			0.67
Uniform Delay, d1	39.5		3.0			3.3
Progression Factor	1.00		0.78			0.98
Incremental Delay, d2	1.0		0.6			2.9
Delay (s)	40.5		3.0			6.2
Level of Service	D		A			A
Approach Delay (s)	40.5		3.0			6.2
Approach LOS	D		A			A

Intersection Summary			
HCM Average Control Delay	6.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	103.7%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
24: Sunflower Road & US 56
AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	5	40	5	270	70	10	5	190	370	10	60	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.99			1.00			0.91			1.00	
Flt Protected		1.00			0.96			1.00			0.99	
Satd. Flow (prot)		1866			1764			1665			1635	
Flt Permitted		0.97			0.74			1.00			0.92	
Satd. Flow (perm)		1811			1358			1664			1522	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	5	42	5	284	74	11	5	200	389	11	63	0
RTOR Reduction (vph)	0	3	0	0	1	0	0	68	0	0	0	0
Lane Group Flow (vph)	0	49	0	0	368	0	0	526	0	0	74	0
Heavy Vehicles (%)	0%	0%	0%	4%	1%	0%	0%	6%	3%	0%	18%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		28.4			28.4			51.6			51.6	
Effective Green, g (s)		28.4			28.4			51.6			51.6	
Actuated g/C Ratio		0.32			0.32			0.57			0.57	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		571			429			954			873	
v/s Ratio Prot												
v/s Ratio Perm		0.03			c0.27			c0.32			0.05	
v/c Ratio		0.09			0.86			0.55			0.08	
Uniform Delay, d1		21.7			28.9			12.0			8.6	
Progression Factor		1.00			0.75			0.69			1.10	
Incremental Delay, d2		0.1			12.0			2.0			0.2	
Delay (s)		21.7			33.7			10.3			9.7	
Level of Service		C			C			B			A	
Approach Delay (s)		21.7			33.7			10.3			9.7	
Approach LOS		C			C			B			A	

Intersection Summary			
HCM Average Control Delay	18.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	67.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
25: US 56 & 4th Street
AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	480	130	90	250	110	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0			5.0	5.0	
Lane Util. Factor	1.00			1.00	1.00	
Frt	0.97			1.00	0.94	
Flt Protected	1.00			0.99	0.97	
Satd. Flow (prot)	1778			1782	1676	
Flt Permitted	1.00			0.74	0.97	
Satd. Flow (perm)	1778			1340	1676	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	505	137	95	263	116	95
RTOR Reduction (vph)	8	0	0	0	36	0
Lane Group Flow (vph)	634	0	0	358	175	0
Heavy Vehicles (%)	4%	3%	3%	6%	5%	2%
Turn Type			Perm			
Protected Phases	4			8	2	
Permitted Phases			8			
Actuated Green, G (s)	65.5			65.5	14.5	
Effective Green, g (s)	65.5			65.5	14.5	
Actuated g/C Ratio	0.73			0.73	0.16	
Clearance Time (s)	5.0			5.0	5.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	1294			975	270	
v/s Ratio Prot	c0.36				c0.10	
v/s Ratio Perm				0.27		
v/c Ratio	0.49			0.37	0.65	
Uniform Delay, d1	5.2			4.6	35.4	
Progression Factor	1.00			0.28	1.00	
Incremental Delay, d2	1.3			0.9	5.3	
Delay (s)	6.5			2.1	40.6	
Level of Service	A			A	D	
Approach Delay (s)	6.5			2.1	40.6	
Approach LOS	A			A	D	

Intersection Summary			
HCM Average Control Delay	11.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	75.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

26: 199th Street & Four Corners Road — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	420	360	130	120	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	442	379	137	126	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	516				900	447
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	516				900	447
tC, single (s)	4.5				7.4	6.6
tC, 2 stage (s)						
tF (s)	2.6				4.4	3.7
p0 queue free %	99				40	98
cM capacity (veh/h)	882				211	539

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	447	516	137
Volume Left	5	0	126
Volume Right	0	137	11
cSH	882	1700	221
Volume to Capacity	0.01	0.30	0.62
Queue Length 95th (ft)	0	0	91
Control Delay (s)	0.2	0.0	44.5
Lane LOS	A		E
Approach Delay (s)	0.2	0.0	44.5
Approach LOS			E

Intersection Summary			
Average Delay	5.6		
Intersection Capacity Utilization	40.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

27: 199th Street & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	170	10	30	150	450	10	260	20	290	90	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00		1.00		1.00	1.00	1.00
Frt	1.00	0.99		1.00	1.00	0.85		0.99		1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		1.00		0.95	1.00	1.00
Satd. Flow (prot)	1752	1783		1752	1845	1583		1830		1770	1863	1583
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.99		0.45	1.00	1.00
Satd. Flow (perm)	1752	1783		1752	1845	1583		1818		841	1863	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	42	179	11	32	158	474	11	274	21	305	95	53
RTOR Reduction (vph)	0	3	0	0	0	394	0	2	0	0	0	20
Lane Group Flow (vph)	42	187	0	32	158	80	0	304	0	305	95	33
Heavy Vehicles (%)	3%	6%	0%	3%	3%	2%	0%	3%	0%	2%	2%	2%
Turn Type	Prot			Prot		Perm	Perm			pm+pt		Perm
Protected Phases	5	2		1	6			8		7	4	
Permitted Phases						6	8			4		4
Actuated Green, G (s)	4.4	14.7		4.9	15.2	15.2		38.0		55.4	55.4	55.4
Effective Green, g (s)	4.4	14.7		4.9	15.2	15.2		38.0		55.4	55.4	55.4
Actuated g/C Ratio	0.05	0.16		0.05	0.17	0.17		0.42		0.62	0.62	0.62
Clearance Time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	86	291		95	312	267		768		646	1147	974
v/s Ratio Prot	0.02	c0.11		0.02	c0.09					c0.07	0.05	
v/s Ratio Perm						0.05		0.17		c0.23		0.02
v/c Ratio	0.49	0.64		0.34	0.51	0.30		0.40		0.47	0.08	0.03
Uniform Delay, d1	41.7	35.2		41.0	34.0	32.7		18.0		9.3	7.0	6.8
Progression Factor	0.92	1.03		1.00	1.00	1.00		1.00		1.55	1.42	2.31
Incremental Delay, d2	4.3	4.8		2.1	1.3	0.6		1.5		0.4	0.1	0.0
Delay (s)	42.7	40.9		43.1	35.3	33.4		19.6		14.8	10.1	15.7
Level of Service	D	D		D	D	C		B		B	B	B
Approach Delay (s)		41.3			34.3			19.6			13.9	
Approach LOS		D			C			B			B	

Intersection Summary			
HCM Average Control Delay	27.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	61.1%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

30: US-56 & I-35 NB Loop — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	1330	1630	0	1780	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	1400	1716	0	1874	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked					0.62	
vC, conflicting volume			3116		2337	700
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			3116		1922	700
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			105		37	386

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	700	700	1716	937	937
Volume Left	0	0	0	0	0
Volume Right	0	0	1716	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.41	0.41	1.01	0.55	0.55
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	104.3%	ICU Level of Service	G
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

37: 199th Street & West Waverley — AM Peak Hour

Movement	EBL	EBT	WBU	WBT	WBR	SBL	SBR
Lane Configurations							
Volume (veh/h)	10	790	0	740	130	100	10
Sign Control		Free		Free		Stop	
Grade		0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	859	0	804	141	109	11
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type		TWLTL		TWLTL			
Median storage veh)		2		2			
Upstream signal (ft)				802			
pX, platoon unblocked	1.00		0.00			1.00	1.00
vC, conflicting volume	946		0			1755	875
vC1, stage 1 conf vol						875	
vC2, stage 2 conf vol						880	
vCu, unblocked vol	944		0			1756	873
tC, single (s)	4.1		0.0			6.9	6.2
tC, 2 stage (s)						5.9	
tF (s)	2.2		0.0			4.0	3.3
p0 queue free %	99		0			55	97
cM capacity (veh/h)	733		0			240	351

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	11	859	946	0	120
Volume Left	11	0	0	0	109
Volume Right	0	0	141	0	11
cSH	733	1700	1700	1700	247
Volume to Capacity	0.01	0.51	0.56	0.00	0.48
Queue Length 95th (ft)	1	0	0	0	61
Control Delay (s)	10.0	0.0	0.0	0.0	32.5
Lane LOS	A				D
Approach Delay (s)	0.1		0.0		32.5
Approach LOS					D

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	59.7%	ICU Level of Service	B
Analysis Period (min)	15		

2030 Gardner IMF Operations - (Improved) - AM Peak Hour - Synchro Intersection LOS

38: 199th Street & IH-35 SB Ramp

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	830	70	50	300	0	0	0	0	10	0	570
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		1.00		1.00	1.00					1.00		1.00
Frt		0.99		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		1566		1770	1827					1805		1346
Flt Permitted		1.00		0.18	1.00					0.95		1.00
Satd. Flow (perm)		1566		332	1827					1805		1346
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	902	76	54	326	0	0	0	0	11	0	620
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	586
Lane Group Flow (vph)	0	976	0	54	326	0	0	0	0	11	0	34
Heavy Vehicles (%)	0%	21%	9%	2%	4%	0%	0%	0%	0%	0%	0%	20%
Turn Type				pm+pt						Prot		custom
Protected Phases		4		3	8					6		
Permitted Phases				8								6
Actuated Green, G (s)		65.2		75.0	75.0					5.0		5.0
Effective Green, g (s)		65.2		75.0	75.0					5.0		5.0
Actuated g/C Ratio		0.72		0.83	0.83					0.06		0.06
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		1134		353	1523					100		75
v/s Ratio Prot		c0.62		0.01	c0.18					0.01		
v/s Ratio Perm				0.12								c0.03
v/c Ratio		0.86		0.15	0.21					0.11		0.46
Uniform Delay, d1		9.1		6.6	1.5					40.4		41.2
Progression Factor		0.71		1.87	1.94					1.00		1.00
Incremental Delay, d2		8.5		0.2	0.1					0.5		4.4
Delay (s)		14.9		12.6	3.0					40.9		45.6
Level of Service		B		B	A					D		D
Approach Delay (s)		14.9			4.4			0.0			45.5	
Approach LOS		B			A			A			D	

Intersection Summary			
HCM Average Control Delay	22.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	74.3%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

39: 199th Street & IH-35 NB Ramp

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	750	90	0	0	140	20	210	0	90	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0		5.0			
Lane Util. Factor	1.00	1.00			1.00		1.00		1.00			
Frt	1.00	1.00			0.98		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1467	1759			1805		1752		1583			
Flt Permitted	0.43	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	671	1759			1805		1752		1583			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	815	98	0	0	152	22	228	0	98	0	0	0
RTOR Reduction (vph)	0	0	0	0	6	0	0	0	82	0	0	0
Lane Group Flow (vph)	815	98	0	0	168	0	228	0	16	0	0	0
Heavy Vehicles (%)	23%	8%	0%	0%	4%	0%	3%	0%	2%	0%	0%	0%
Turn Type	pm+pt						custom		custom			
Protected Phases	7	4			8							
Permitted Phases	4						2		2			
Actuated Green, G (s)	64.9	64.9			18.3		15.1		15.1			
Effective Green, g (s)	64.9	64.9			18.3		15.1		15.1			
Actuated g/C Ratio	0.72	0.72			0.20		0.17		0.17			
Clearance Time (s)	5.0	5.0			5.0		5.0		5.0			
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Lane Grp Cap (vph)	852	1268			367		294		266			
v/s Ratio Prot	c0.44	0.06			0.09							
v/s Ratio Perm	c0.25						c0.13		0.01			
v/c Ratio	0.96	0.08			0.46		0.78		0.06			
Uniform Delay, d1	11.9	3.7			31.5		35.8		31.5			
Progression Factor	0.44	0.12			0.53		1.00		1.00			
Incremental Delay, d2	13.2	0.1			0.9		12.1		0.1			
Delay (s)	18.4	0.5			17.7		47.9		31.6			
Level of Service	B	A			B		D		C			
Approach Delay (s)		16.5			17.7			43.0			0.0	
Approach LOS		B			B			D			A	

Intersection Summary			
HCM Average Control Delay	22.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	74.3%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

40: 199th Street & East Waverley

AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	160	10	5	150	10	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	174	11	5	163	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	820					
pX, platoon unblocked						
vC, conflicting volume			185		353	179
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			185		353	179
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	99
cM capacity (veh/h)			1402		646	869

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	185	168	16
Volume Left	0	5	11
Volume Right	11	0	5
cSH	1700	1402	706
Volume to Capacity	0.11	0.00	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.3	10.2
Lane LOS		A	B
Approach Delay (s)	0.0	0.3	10.2
Approach LOS			B

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	21.9%	ICU Level of Service	A
Analysis Period (min)	15		

80: 191st Street & Driveway A

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	110	20	10	5	60	120
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	120	22	11	5	65	130
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	16				274	14
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	16				274	14
tC, single (s)	5.1				7.4	7.2
tC, 2 stage (s)						
tF (s)	3.1				4.4	4.2
p0 queue free %	90				87	84
cM capacity (veh/h)	1143				491	841

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	141	16	65	130
Volume Left	120	0	65	0
Volume Right	0	5	0	130
cSH	1143	1700	491	841
Volume to Capacity	0.10	0.01	0.13	0.16
Queue Length 95th (ft)	9	0	11	14
Control Delay (s)	7.3	0.0	13.5	10.1
Lane LOS	A		B	B
Approach Delay (s)	7.3	0.0	11.2	
Approach LOS			B	

Intersection Summary			
Average Delay	9.1		
Intersection Capacity Utilization	23.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
82: Driveway C & Waverly Road — AM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	60	50	60	190	140	50
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	65	54	65	207	152	54
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	516	179	207			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	516	179	207			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	87	94	95			
cM capacity (veh/h)	498	869	1377			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	65	54	272	207
Volume Left	65	0	65	0
Volume Right	0	54	0	54
cSH	498	869	1377	1700
Volume to Capacity	0.13	0.06	0.05	0.12
Queue Length 95th (ft)	11	5	4	0
Control Delay (s)	13.3	9.4	2.2	0.0
Lane LOS	B	A	A	
Approach Delay (s)	11.5		2.2	0.0
Approach LOS	B			

Intersection Summary			
Average Delay	3.3		
Intersection Capacity Utilization	37.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
84: 191st Street & Driveway E — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	70	10	20	30	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	76	11	22	33	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	33				120	22
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	33				120	22
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				96	99
cM capacity (veh/h)	1592				875	1061

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	87	33	38
Volume Left	11	0	33
Volume Right	0	22	5
cSH	1592	1700	897
Volume to Capacity	0.01	0.02	0.04
Queue Length 95th (ft)	1	0	3
Control Delay (s)	1.0	0.0	9.2
Lane LOS	A		A
Approach Delay (s)	1.0	0.0	9.2
Approach LOS			A

Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	20.9%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner IMF Operations - (Improved + Mitigated) - AM Peak Hour - Synchro Intersection LOS

1: 175th Street & Waverly Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Volume (vph)	70	20	640	10	10	10	380	250	10	20	220	50
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.93		1.00	0.99		1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1736	1677		1805	1850		1770	3521		1805	3389	
Flt Permitted	0.74	1.00		0.23	1.00		0.58	1.00		0.58	1.00	
Satd. Flow (perm)	1357	1677		442	1850		1075	3521		1108	3389	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	21	674	11	11	11	400	263	11	21	232	53
RTOR Reduction (vph)	0	485	0	0	9	0	0	2	0	0	14	0
Lane Group Flow (vph)	74	210	0	11	13	0	400	272	0	21	271	0
Heavy Vehicles (%)	4%	0%	2%	0%	0%	0%	2%	2%	0%	0%	3%	6%
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	17.2	17.2		17.2	17.2		62.8	52.8		51.6	46.6	
Effective Green, g (s)	17.2	17.2		17.2	17.2		62.8	52.8		51.6	46.6	
Actuated g/C Ratio	0.19	0.19		0.19	0.19		0.70	0.59		0.57	0.52	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	259	320		84	354		837	2066		674	1755	
v/s Ratio Prot		c0.13			0.01		c0.06	0.08		0.00	0.08	
v/s Ratio Perm	0.05			0.02			c0.27			0.02		
v/c Ratio	0.29	0.66		0.13	0.04		0.48	0.13		0.03	0.15	
Uniform Delay, d1	31.1	33.7		30.2	29.7		6.5	8.3		8.4	11.4	
Progression Factor	1.00	1.00		1.00	1.00		0.80	0.42		1.00	1.00	
Incremental Delay, d2	0.6	4.8		0.7	0.0		0.4	0.1		0.0	0.2	
Delay (s)	31.8	38.4		30.9	29.7		5.7	3.6		8.4	11.6	
Level of Service	C	D		C	C		A	A		A	B	
Approach Delay (s)		37.8			30.1			4.8			11.3	
Approach LOS		D			C			A			B	

Intersection Summary			
HCM Average Control Delay	20.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	79.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

2: US 56 & Gardner Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↑	↱	↰	↑↑	↱	↰↰	↑↱	
Volume (vph)	140	830	60	180	420	250	70	1000	310	380	830	150
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1752	3619	1583	1687	3519	1553	1752	3689	1553	3400	3435	
Flt Permitted	0.43	1.00	1.00	0.16	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	792	3619	1583	282	3519	1553	1752	3689	1553	3400	3435	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	147	874	63	189	442	263	74	1053	326	400	874	158
RTOR Reduction (vph)	0	0	39	0	0	189	0	0	117	0	16	0
Lane Group Flow (vph)	147	874	24	189	442	74	74	1053	209	400	1016	0
Heavy Vehicles (%)	3%	5%	2%	7%	8%	4%	3%	3%	4%	3%	3%	1%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			
Actuated Green, G (s)	31.4	24.8	24.8	32.2	25.2	25.2	5.9	29.7	29.7	11.8	35.6	
Effective Green, g (s)	31.4	24.8	24.8	32.2	25.2	25.2	5.9	29.7	29.7	11.8	35.6	
Actuated g/C Ratio	0.35	0.28	0.28	0.36	0.28	0.28	0.07	0.33	0.33	0.13	0.40	
Clearance Time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	347	997	436	210	985	435	115	1217	512	446	1359	
v/s Ratio Prot	0.03	0.24		c0.07	0.13		0.04	c0.29		c0.12	0.30	
v/s Ratio Perm	0.12		0.02	c0.25		0.05			0.13			
v/c Ratio	0.42	0.88	0.05	0.90	0.45	0.17	0.64	0.87	0.41	0.90	0.75	
Uniform Delay, d1	20.9	31.1	24.0	23.5	26.7	24.5	41.0	28.3	23.3	38.5	23.3	
Progression Factor	0.61	0.70	0.57	1.35	1.05	2.65	0.74	0.59	0.24	1.00	1.00	
Incremental Delay, d2	0.8	10.1	0.2	34.7	1.4	0.8	8.1	4.6	0.4	20.2	2.3	
Delay (s)	13.5	31.8	14.0	66.5	29.5	65.7	38.2	21.3	6.0	58.7	25.6	
Level of Service	B	C	B	E	C	E	D	C	A	E	C	
Approach Delay (s)		28.3			48.0			18.7			34.9	
Approach LOS		C			D			B			C	

Intersection Summary			
HCM Average Control Delay	31.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	13.3
Intersection Capacity Utilization	85.3%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

3: US 56 & Elm

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱			↰↑↱		↰	↱		↰	↱	
Volume (vph)	20	1510	10	10	800	90	10	10	30	110	10	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			0.98		1.00	0.89		1.00	0.88	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3436			3339		1805	1651		1770	1610	
Flt Permitted		0.94			0.93		0.72	1.00		0.73	1.00	
Satd. Flow (perm)		3215			3101		1373	1651		1358	1610	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	1589	11	11	842	95	11	11	32	116	11	42
RTOR Reduction (vph)	0	0	0	0	6	0	0	28	0	0	37	0
Lane Group Flow (vph)	0	1621	0	0	942	0	11	15	0	116	16	0
Heavy Vehicles (%)	0%	5%	0%	0%	7%	2%	0%	0%	3%	2%	0%	5%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		69.5			69.5		11.5	11.5		11.5	11.5	
Effective Green, g (s)		69.5			69.5		11.5	11.5		11.5	11.5	
Actuated g/C Ratio		0.77			0.77		0.13	0.13		0.13	0.13	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2483			2395		175	211		174	206	
v/s Ratio Prot								0.01			0.01	
v/s Ratio Perm		c0.50			0.30		0.01			c0.09		
v/c Ratio		0.65			0.39		0.06	0.07		0.67	0.08	
Uniform Delay, d1		4.7			3.4		34.5	34.6		37.4	34.6	
Progression Factor		0.69			0.98		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.8			0.5		0.2	0.1		9.3	0.2	
Delay (s)		4.1			3.7		34.7	34.7		46.7	34.8	
Level of Service		A			A		C	C		D	C	
Approach Delay (s)		4.1			3.7			34.7			43.0	
Approach LOS		A			A			C			D	

Intersection Summary			
HCM Average Control Delay	6.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	76.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

4: US 56 & Mulberry

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱			↰↑↱		↰	↱		↰	↱	
Volume (vph)	40	1670	10	10	850	60	5	5	20	100	5	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			0.99		1.00	0.88		1.00	0.87	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3464			3339		1805	1548		1770	1612	
Flt Permitted		0.90			0.92		0.73	1.00		0.74	1.00	
Satd. Flow (perm)		3135			3085		1393	1548		1379	1612	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	42	1758	11	11	895	63	5	5	21	105	5	32
RTOR Reduction (vph)	0	0	0	0	5	0	0	19	0	0	28	0
Lane Group Flow (vph)	0	1811	0	0	964	0	5	7	0	105	9	0
Heavy Vehicles (%)	5%	4%	0%	0%	7%	8%	0%	20%	5%	2%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		71.0			71.0		10.0	10.0		10.0	10.0	
Effective Green, g (s)		71.0			71.0		10.0	10.0		10.0	10.0	
Actuated g/C Ratio		0.79			0.79		0.11	0.11		0.11	0.11	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2473			2434		155	172		153	179	
v/s Ratio Prot								0.00			0.01	
v/s Ratio Perm		c0.58			0.31		0.00			c0.08		
v/c Ratio		0.73			0.40		0.03	0.04		0.69	0.05	
Uniform Delay, d1		4.7			2.9		35.7	35.7		38.5	35.7	
Progression Factor		0.33			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.6			0.1		0.1	0.1		12.0	0.1	
Delay (s)		3.2			3.0		35.8	35.8		50.5	35.9	
Level of Service		A			A		D	D		D	D	
Approach Delay (s)		3.2			3.0			35.8			46.7	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	5.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	94.9%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

5: US 56 & Moonlight Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	180	1430	200	150	690	590	140	620	270	1160	530	110
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1719	3654	1568	1770	3519	1583	1770	3725	1553	3433	3539	1553
Flt Permitted	0.21	1.00	1.00	0.10	1.00	1.00	0.44	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	386	3654	1568	188	3519	1583	825	3725	1553	3433	3539	1553
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	189	1505	211	158	726	621	147	653	284	1221	558	116
RTOR Reduction (vph)	0	0	56	0	0	340	0	0	81	0	0	79
Lane Group Flow (vph)	189	1505	155	158	726	281	147	653	203	1221	558	37
Heavy Vehicles (%)	5%	4%	3%	2%	8%	2%	2%	2%	4%	2%	2%	4%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		custom	Prot		Perm
Protected Phases	5	2		1	6		3	8	8	7	4	
Permitted Phases	2		2	6		6	8		8			4
Actuated Green, G (s)	52.4	43.0	43.0	45.6	39.6	39.6	26.7	16.5	16.5	31.5	37.8	37.8
Effective Green, g (s)	52.4	43.0	43.0	45.6	39.6	39.6	26.7	16.5	16.5	31.5	37.8	37.8
Actuated g/C Ratio	0.44	0.36	0.36	0.38	0.33	0.33	0.22	0.14	0.14	0.26	0.31	0.31
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	273	1309	562	151	1161	522	264	512	214	901	1115	489
v/s Ratio Prot	0.05	c0.41		c0.05	0.21		0.05	c0.18	0.13	c0.36	0.16	
v/s Ratio Perm	0.25		0.10	0.35		0.18	0.08					0.02
v/c Ratio	0.69	1.15	0.28	1.05	0.63	0.54	0.56	1.28	0.95	1.36	0.50	0.07
Uniform Delay, d1	23.4	38.5	27.4	34.2	33.9	32.7	39.6	51.8	51.3	44.2	33.4	28.8
Progression Factor	1.00	1.00	1.00	1.14	0.89	1.12	0.90	0.83	0.70	1.00	1.00	1.00
Incremental Delay, d2	6.0	76.7	1.2	82.7	2.3	3.6	1.2	136.3	41.3	167.1	0.1	0.0
Delay (s)	29.4	115.2	28.6	121.9	32.5	40.2	37.0	179.0	77.3	211.4	33.6	28.9
Level of Service	C	F	C	F	C	D	D	F	E	F	C	C
Approach Delay (s)		97.1			45.1			133.1			147.8	
Approach LOS		F			D			F			F	

Intersection Summary			
HCM Average Control Delay	106.0	HCM Level of Service	F
HCM Volume to Capacity ratio	1.23		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	114.4%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

6: Old US 56 & US 56 — AM Peak Hour

Movement	NBL	NBR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	150	10	1870	1000	10	1300
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	0.97	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	3433	1615	3654	1583	1805	3585
Flt Permitted	0.95	1.00	1.00	1.00	0.06	1.00
Satd. Flow (perm)	3433	1615	3654	1583	119	3585
Peak-hour factor, PHF	0.97	0.97	0.95	0.95	0.95	0.95
Adj. Flow (vph)	155	10	1968	1053	11	1368
RTOR Reduction (vph)	0	9	0	123	0	0
Lane Group Flow (vph)	155	1	1968	930	11	1368
Heavy Vehicles (%)	2%	0%	4%	2%	0%	6%
Turn Type		Perm		pm+ov	pm+pt	
Protected Phases	8		2	8	1	6
Permitted Phases		8	2	2	6	6
Actuated Green, G (s)	13.1	13.1	90.7	103.8	96.9	96.9
Effective Green, g (s)	13.1	13.1	90.7	103.8	96.9	96.9
Actuated g/C Ratio	0.11	0.11	0.76	0.86	0.81	0.81
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	375	176	2762	1435	113	2895
v/s Ratio Prot	0.05		c0.54	c0.07	0.00	c0.38
v/s Ratio Perm		0.00		0.52	0.08	
v/c Ratio	0.41	0.01	0.71	0.65	0.10	0.47
Uniform Delay, d1	49.9	47.6	7.8	2.5	9.2	3.6
Progression Factor	1.00	1.00	0.75	15.44	1.25	1.20
Incremental Delay, d2	0.7	0.0	0.1	0.1	0.2	0.3
Delay (s)	50.6	47.7	6.0	38.5	11.7	4.6
Level of Service	D	D	A	D	B	A
Approach Delay (s)	50.4		17.3			4.7
Approach LOS	D		B			A

Intersection Summary			
HCM Average Control Delay	14.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	73.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

7: US-56 & Cedar Niles — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	2050	160	670	2100	100	130	30	760	60	20	70
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2	5.2	5.2	5.2	5.2
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00	1.00	1.00	0.88	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1787	3725	1583	3433	3689	1583	1770	1942	2787	1752	2000	1553
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.74	1.00	1.00	0.74	1.00	1.00
Satd. Flow (perm)	1787	3725	1583	3433	3689	1583	1385	1942	2787	1358	2000	1553
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	2158	168	705	2211	105	137	32	800	63	21	74
RTOR Reduction (vph)	0	0	67	0	0	28	0	0	0	0	0	65
Lane Group Flow (vph)	74	2158	101	705	2211	77	137	32	800	63	21	9
Heavy Vehicles (%)	1%	2%	2%	2%	3%	2%	2%	3%	2%	3%	0%	4%
Turn Type	Prot		Perm	Prot		Perm	Perm		pt+ov	Perm		Perm
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases			2			6	8			4		4
Actuated Green, G (s)	5.6	68.8	68.8	23.0	86.2	86.2	12.6	12.6	40.8	12.6	12.6	12.6
Effective Green, g (s)	5.6	68.8	68.8	23.0	86.2	86.2	12.6	12.6	40.8	12.6	12.6	12.6
Actuated g/C Ratio	0.05	0.57	0.57	0.19	0.72	0.72	0.10	0.10	0.34	0.10	0.10	0.10
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2		5.2	5.2	5.2
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lane Grp Cap (vph)	83	2136	908	658	2650	1137	145	204	948	143	210	163
v/s Ratio Prot	0.04	c0.58		c0.21	0.60			0.02	c0.29		0.01	
v/s Ratio Perm			0.06			0.05	0.10			0.05		0.01
v/c Ratio	0.89	1.01	0.11	1.07	0.83	0.07	0.94	0.16	0.84	0.44	0.10	0.05
Uniform Delay, d1	56.9	25.6	11.7	48.5	11.9	5.0	53.4	48.9	36.7	50.4	48.6	48.3
Progression Factor	0.87	0.76	0.40	1.07	1.00	1.01	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	55.8	20.4	0.2	40.2	0.8	0.0	57.3	0.1	6.7	0.8	0.1	0.0
Delay (s)	105.2	39.8	4.9	91.9	12.7	5.1	110.7	49.0	43.3	51.2	48.6	48.4
Level of Service	F	D	A	F	B	A	F	D	D	D	D	D
Approach Delay (s)		39.4			30.9			53.0			49.5	
Approach LOS		D			C			D			D	

Intersection Summary			
HCM Average Control Delay	37.7	HCM Level of Service	D
HCM Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.6
Intersection Capacity Utilization	102.8%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

8: US-56 & I-35 SB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	2750	90	330	1450	0	0	0	0	210	0	1370
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		1.00		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3509		1719	3725					1736		2760
Flt Permitted		1.00		0.11	1.00					0.95		1.00
Satd. Flow (perm)		3509		203	3725					1736		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2895	95	347	1526	0	0	0	0	221	0	1442
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	2988	0	347	1526	0	0	0	0	221	0	1442
Heavy Vehicles (%)	0%	2%	14%	5%	2%	0%	0%	0%	0%	4%	0%	3%
Turn Type				pm+pt						custom		custom
Protected Phases		2		1	6					4		5
Permitted Phases				6						4		4
Actuated Green, G (s)		77.0		51.6	51.6					12.0		53.4
Effective Green, g (s)		77.0		51.6	51.6					12.0		53.4
Actuated g/C Ratio		0.64		0.43	0.43					0.10		0.44
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2252		289	1602					174		1343
v/s Ratio Prot		c0.85		c0.16	0.41					0.13		c0.37
v/s Ratio Perm				0.36								0.15
v/c Ratio		1.33		1.20	0.95					1.27		1.07
Uniform Delay, d1		21.5		35.6	33.0					54.0		33.3
Progression Factor		0.72		0.91	0.88					1.00		1.00
Incremental Delay, d2		148.1		110.7	9.6					158.8		47.0
Delay (s)		163.5		143.0	38.7					212.8		80.3
Level of Service		F		F	D					F		F
Approach Delay (s)		163.5			58.0			0.0			97.9	
Approach LOS		F			E			A			F	

Intersection Summary			
HCM Average Control Delay	116.5	HCM Level of Service	F
HCM Volume to Capacity ratio	1.25		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	120.5%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner IMF Operations - (Improved + Mitigated) - AM Peak Hour - Synchro Intersection LOS

9: US-56 & I-35 NB Ramps

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1320	0	0	1610	510	170	0	700	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95	0.95			
Frt		1.00			1.00	0.85	1.00	0.85	0.85			
Flt Protected		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (prot)		3725			3539	1583	1687	1475	1475			
Flt Permitted		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (perm)		3725			3539	1583	1687	1475	1475			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1389	0	0	1695	537	179	0	737	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	110	0	0	0	0	0	0
Lane Group Flow (vph)	0	1389	0	0	1695	427	179	369	368	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	2%	7%	0%	4%	0%	0%	0%
Turn Type						Perm	Perm		Perm			
Protected Phases		2			6			8				
Permitted Phases						6	8		8			
Actuated Green, G (s)		74.6			74.6	74.6	35.4	35.4	35.4			
Effective Green, g (s)		74.6			74.6	74.6	35.4	35.4	35.4			
Actuated g/C Ratio		0.62			0.62	0.62	0.29	0.29	0.29			
Clearance Time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0	3.0			
Lane Grp Cap (vph)		2316			2200	984	498	435	435			
v/s Ratio Prot		0.37			c0.48			c0.25				
v/s Ratio Perm						0.27	0.11		0.25			
v/c Ratio		0.60			0.77	0.43	0.36	0.85	0.85			
Uniform Delay, d1		13.7			16.5	11.8	33.4	39.8	39.7			
Progression Factor		0.50			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2		0.1			1.7	0.3	0.4	14.2	14.1			
Delay (s)		6.9			18.2	12.1	33.8	54.0	53.8			
Level of Service		A			B	B	C	D	D			
Approach Delay (s)		6.9			16.7			50.0			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	20.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	104.3%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

10: Santa Fe & Moonlight Road

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	120	320	710	240	460	410
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.96		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3380		1770	3505
Flt Permitted	0.95	1.00	1.00		0.21	1.00
Satd. Flow (perm)	1770	1583	3380		396	3505
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	126	337	747	253	484	432
RTOR Reduction (vph)	0	298	20	0	0	0
Lane Group Flow (vph)	126	39	980	0	484	432
Heavy Vehicles (%)	2%	2%	3%	2%	2%	3%
Turn Type		Perm			pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8			6	
Actuated Green, G (s)	13.8	13.8	64.4		96.2	96.2
Effective Green, g (s)	13.8	13.8	64.4		96.2	96.2
Actuated g/C Ratio	0.12	0.12	0.54		0.80	0.80
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	204	182	1814		624	2810
v/s Ratio Prot	c0.07		0.29		c0.17	0.12
v/s Ratio Perm		0.02			c0.45	
v/c Ratio	0.62	0.21	0.54		0.78	0.15
Uniform Delay, d1	50.6	48.2	18.1		18.5	2.7
Progression Factor	1.00	1.00	1.00		0.59	0.78
Incremental Delay, d2	5.5	0.6	1.2		5.1	0.1
Delay (s)	56.1	48.8	19.3		16.1	2.2
Level of Service	E	D	B		B	A
Approach Delay (s)	50.7		19.3			9.5
Approach LOS	D		B			A

Intersection Summary			
HCM Average Control Delay	21.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	71.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

11: Waverly Road & US 56

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	20	250	120	560	250	40	70	140	20	90	70	310
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95		1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.98		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1805	3539	1538	3400	3458		1736	3312	1615	1752	2935	1568
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1805	3539	1538	3400	3458		1736	3312	1615	1752	2935	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	263	126	589	263	42	74	147	21	95	74	326
RTOR Reduction (vph)	0	0	109	0	15	0	0	0	16	0	0	230
Lane Group Flow (vph)	21	263	17	589	290	0	74	147	5	95	74	96
Heavy Vehicles (%)	0%	2%	5%	3%	1%	10%	4%	9%	0%	3%	23%	3%
Turn Type	Prot		Perm	Prot			Prot		Perm	Prot		Perm
Protected Phases	3	8		7	4		5	2		1	6	
Permitted Phases			8					2	2			6
Actuated Green, G (s)	3.1	12.1	12.1	23.7	32.7		7.8	22.7	22.7	11.5	26.4	26.4
Effective Green, g (s)	3.1	12.1	12.1	23.7	32.7		7.8	22.7	22.7	11.5	26.4	26.4
Actuated g/C Ratio	0.03	0.13	0.13	0.26	0.36		0.09	0.25	0.25	0.13	0.29	0.29
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	62	476	207	895	1256		150	835	407	224	861	460
v/s Ratio Prot	0.01	c0.07		c0.17	0.08		0.04	0.04		c0.05	0.03	
v/s Ratio Perm			0.01						0.00			c0.06
v/c Ratio	0.34	0.55	0.08	0.66	0.23		0.49	0.18	0.01	0.42	0.09	0.21
Uniform Delay, d1	42.4	36.4	34.1	29.5	19.9		39.2	26.3	25.2	36.2	23.1	23.9
Progression Factor	0.96	0.98	0.92	0.95	0.93		0.81	0.81	0.70	1.36	0.66	0.78
Incremental Delay, d2	3.2	1.4	0.2	1.5	0.1		2.3	0.4	0.1	1.1	0.2	0.9
Delay (s)	44.2	37.0	31.6	29.5	18.6		34.0	21.9	17.8	50.2	15.3	19.5
Level of Service	D	D	C	C	B		C	C	B	D	B	B
Approach Delay (s)		35.7			25.8			25.2			24.8	
Approach LOS		D			C			C			C	

Intersection Summary			
HCM Average Control Delay	27.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.46		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	48.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

12: 183rd Street & Four Corners Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	20	5	5	40	5	10	20	5	5	50	5
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	21	5	5	42	5	11	21	5	5	53	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	32	53	37	63
Volume Left (vph)	5	5	11	5
Volume Right (vph)	5	5	5	5
Hadj (s)	-0.07	0.00	0.02	0.02
Departure Headway (s)	4.1	4.2	4.2	4.1
Degree Utilization, x	0.04	0.06	0.04	0.07
Capacity (veh/h)	849	842	834	847
Control Delay (s)	7.3	7.4	7.4	7.5
Approach Delay (s)	7.3	7.4	7.4	7.5
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.4		
HCM Level of Service	A		
Intersection Capacity Utilization	14.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

13: 183rd Street & US 56

AM Peak Hour

Intersection Sign configuration not allowed in HCM analysis.

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

14: 183rd Street & Waverly Road

AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	20	160	230	20	190	170
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	168	242	21	200	179
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	832	253			263	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	832	253			263	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	93	79			85	
cM capacity (veh/h)	290	791			1313	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	189	263	379
Volume Left	21	0	200
Volume Right	168	21	0
cSH	664	1700	1313
Volume to Capacity	0.29	0.15	0.15
Queue Length 95th (ft)	29	0	13
Control Delay (s)	12.6	0.0	5.0
Lane LOS	B		A
Approach Delay (s)	12.6	0.0	5.0
Approach LOS	B		

Intersection Summary			
Average Delay	5.1		
Intersection Capacity Utilization	53.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

15: 183rd Street & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	120	80	200	230	110	120	150	1070	210	100	930	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.89		1.00	0.92		1.00	0.98		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1658		1770	1717		1787	3424		1770	3483	
Flt Permitted	0.51	1.00		0.23	1.00		0.19	1.00		0.11	1.00	
Satd. Flow (perm)	949	1658		421	1717		362	3424		205	3483	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	126	84	211	242	116	126	158	1126	221	105	979	116
RTOR Reduction (vph)	0	103	0	0	0	0	0	17	0	0	10	0
Lane Group Flow (vph)	126	192	0	242	242	0	158	1330	0	105	1085	0
Heavy Vehicles (%)	2%	3%	2%	2%	2%	2%	1%	3%	2%	2%	2%	2%
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	19.7	13.7		27.7	17.7		42.4	42.4		40.3	40.3	
Effective Green, g (s)	19.7	13.7		27.7	17.7		42.4	42.4		40.3	40.3	
Actuated g/C Ratio	0.22	0.15		0.31	0.20		0.47	0.47		0.45	0.45	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	262	252		279	338		266	1613		160	1560	
v/s Ratio Prot	0.03	0.12		c0.10	0.14		0.04	c0.39		0.03	c0.31	
v/s Ratio Perm	0.07			c0.17			0.24			0.27		
v/c Ratio	0.48	0.76		0.87	0.72		0.59	0.82		0.66	0.70	
Uniform Delay, d1	29.6	36.6		26.2	33.8		26.8	20.6		20.3	19.9	
Progression Factor	1.20	1.15		1.00	1.00		0.73	0.68		0.68	0.81	
Incremental Delay, d2	1.4	12.6		23.5	7.0		2.5	3.5		6.9	1.9	
Delay (s)	36.8	54.5		49.7	40.8		22.1	17.4		20.7	18.0	
Level of Service	D	D		D	D		C	B		C	B	
Approach Delay (s)		49.2			45.3			17.9			18.3	
Approach LOS		D			D			B			B	

Intersection Summary			
HCM Average Control Delay	25.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	87.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

16: Four Corners Road & US 56

AM Peak Hour

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	0	50	30	190	80	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	0	53	32	200	84	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	347	84	84			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	347	84	84			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	95	98			
cM capacity (veh/h)	640	975	1506			

Direction, Lane #	SB 1	NE 1	SW 1
Volume Total	53	232	84
Volume Left	0	32	0
Volume Right	53	0	0
cSH	975	1506	1700
Volume to Capacity	0.05	0.02	0.05
Queue Length 95th (ft)	4	2	0
Control Delay (s)	8.9	1.2	0.0
Lane LOS	A	A	
Approach Delay (s)	8.9	1.2	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	2.0		
Intersection Capacity Utilization	28.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

17: 191st Street & US 56 — AM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	20	5	5	200	70	60
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	5	5	211	74	63
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	326	105	137			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	326	105	137			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	99	100			
cM capacity (veh/h)	670	955	1460			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	26	216	137
Volume Left	21	5	0
Volume Right	5	0	63
cSH	712	1460	1700
Volume to Capacity	0.04	0.00	0.08
Queue Length 95th (ft)	3	0	0
Control Delay (s)	10.2	0.2	0.0
Lane LOS	B	A	
Approach Delay (s)	10.2	0.2	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	24.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

19: 191st Street & Waverly Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	90	60	50	10	50	60	5	100	30	60	50	90
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	95	63	53	11	53	63	5	105	32	63	53	95
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	116			116			505	416	89	468	411	84
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	116			116			505	416	89	468	411	84
tC, single (s)	4.2			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.3			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	93			99			99	79	97	84	89	90
cM capacity (veh/h)	1430			1486			377	490	966	388	495	969

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	211	126	142	211
Volume Left	95	11	5	63
Volume Right	53	63	32	95
cSH	1430	1486	544	574
Volume to Capacity	0.07	0.01	0.26	0.37
Queue Length 95th (ft)	5	1	26	42
Control Delay (s)	3.8	0.7	13.9	14.9
Lane LOS	A	A	B	B
Approach Delay (s)	3.8	0.7	13.9	14.9
Approach LOS			B	B

Intersection Summary			
Average Delay	8.7		
Intersection Capacity Utilization	46.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

20: W 188th Street & Gardner Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	30	260	210	30	240	260	980	260	260	1250	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	5.0	5.0	5.0	2.5	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.87		1.00	0.97		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1787	1845	1583	1770	1613		1752	3524		1770	3689	1553
Flt Permitted	0.32	1.00	1.00	0.70	1.00		0.10	1.00		0.10	1.00	1.00
Satd. Flow (perm)	597	1845	1583	1308	1613		192	3524		190	3689	1553
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	84	33	274	228	33	261	274	1032	283	283	1316	95
RTOR Reduction (vph)	0	0	236	0	223	0	0	26	0	0	0	50
Lane Group Flow (vph)	84	33	38	228	71	0	274	1289	0	283	1316	45
Heavy Vehicles (%)	1%	3%	2%	2%	3%	2%	3%	5%	2%	2%	3%	4%
Turn Type	pm+pt		Perm	pm+pt			pm+pt			pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	16.8	12.6	12.6	20.5	13.2		51.8	38.4		53.4	39.2	39.2
Effective Green, g (s)	16.8	12.6	12.6	20.5	13.2		51.8	38.4		53.4	39.2	39.2
Actuated g/C Ratio	0.19	0.14	0.14	0.23	0.15		0.58	0.43		0.59	0.44	0.44
Clearance Time (s)	5.0	5.0	5.0	2.5	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	167	258	222	335	237		343	1504		362	1607	676
v/s Ratio Prot	0.02	0.02		c0.06	0.04		0.12	c0.37		c0.12	0.36	
v/s Ratio Perm	0.07		0.02	c0.10			0.34			0.34		0.03
v/c Ratio	0.50	0.13	0.17	0.68	0.30		0.80	0.86		0.78	0.82	0.07
Uniform Delay, d1	31.7	33.9	34.1	31.1	34.3		21.8	23.3		22.2	22.3	14.8
Progression Factor	1.00	1.00	1.00	1.00	1.00		0.92	1.12		1.29	0.59	0.50
Incremental Delay, d2	2.4	0.2	0.4	5.6	0.7		10.8	5.8		8.5	2.7	0.0
Delay (s)	34.0	34.1	34.5	36.7	35.0		30.9	31.8		37.2	15.9	7.4
Level of Service	C	C	C	D	C		C	C		D	B	A
Approach Delay (s)		34.4			35.7			31.7			19.0	
Approach LOS		C			D			C			B	

Intersection Summary			
HCM Average Control Delay	27.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	85.5%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

21: I-35 SB Ramps & Gardner Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	210	0	660	10	830	0	0	1550	170
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)				5.0	5.0	2.5	2.5	5.0			5.0	
Lane Util. Factor				1.00	0.95	0.95	1.00	0.95			0.95	
Frt				1.00	0.85	0.85	1.00	1.00			0.99	
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1703	1434	1434	1805	3689			3663	
Flt Permitted				0.95	1.00	1.00	0.09	1.00			1.00	
Satd. Flow (perm)				1703	1434	1434	178	3689			3663	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	221	0	695	11	874	0	0	1632	179
RTOR Reduction (vph)	0	0	0	0	251	56	0	0	0	0	8	0
Lane Group Flow (vph)	0	0	0	221	97	291	11	874	0	0	1803	0
Heavy Vehicles (%)	0%	0%	0%	6%	0%	7%	0%	3%	0%	0%	2%	4%
Turn Type				custom		custom	pm+pt					
Protected Phases				8	8	1	5	2			6	
Permitted Phases				8		8	2					
Actuated Green, G (s)				16.2	16.2	34.9	43.7	42.6			60.2	
Effective Green, g (s)				16.2	16.2	34.9	43.7	42.6			60.2	
Actuated g/C Ratio				0.18	0.18	0.39	0.49	0.47			0.67	
Clearance Time (s)				5.0	5.0	2.5	2.5	5.0			5.0	
Vehicle Extension (s)				3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)				307	258	596	106	1746			2450	
v/s Ratio Prot				c0.13	0.07	c0.10	0.00	0.24			c0.49	
v/s Ratio Perm						0.10	0.05					
v/c Ratio				0.72	0.38	0.49	0.10	0.50			0.74	
Uniform Delay, d1				34.8	32.5	20.8	31.8	16.4			9.7	
Progression Factor				1.00	1.00	1.00	0.89	0.41			0.48	
Incremental Delay, d2				7.9	0.9	0.6	0.1	0.3			1.3	
Delay (s)				42.6	33.4	21.4	28.2	6.9			6.0	
Level of Service				D	C	C	C	A			A	
Approach Delay (s)		0.0			31.1			7.2			6.0	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM Average Control Delay	12.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	93.8%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

22: I-35 NB Ramps & Gardner Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	370	0	40	0	0	0	0	480	450	1070	690	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0						5.0	5.0	5.0	5.0	
Lane Util. Factor		1.00						1.00	1.00	0.97	0.95	
Frt		0.99						1.00	0.85	1.00	1.00	
Flt Protected		0.96						1.00	1.00	0.95	1.00	
Satd. Flow (prot)		1754						1942	1583	3433	3725	
Flt Permitted		0.96						1.00	1.00	0.95	1.00	
Satd. Flow (perm)		1754						1942	1583	3433	3725	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	389	0	42	0	0	0	0	505	474	1126	726	0
RTOR Reduction (vph)	0	5	0	0	0	0	0	0	348	0	0	0
Lane Group Flow (vph)	0	426	0	0	0	0	0	505	126	1126	726	0
Heavy Vehicles (%)	2%	0%	5%	0%	0%	0%	0%	3%	2%	2%	2%	0%
Turn Type	Split								Perm	Prot		
Protected Phases	4	4						2		1	6	
Permitted Phases									2			
Actuated Green, G (s)		22.0						24.0	24.0	29.0	58.0	
Effective Green, g (s)		22.0						24.0	24.0	29.0	58.0	
Actuated g/C Ratio		0.24						0.27	0.27	0.32	0.64	
Clearance Time (s)		5.0						5.0	5.0	5.0	5.0	
Vehicle Extension (s)		3.0						3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)		429						518	422	1106	2401	
v/s Ratio Prot		c0.24						c0.26		c0.33	0.19	
v/s Ratio Perm									0.08			
v/c Ratio		0.99						0.97	0.30	1.02	0.30	
Uniform Delay, d1		33.9						32.7	26.3	30.5	7.1	
Progression Factor		1.00						0.86	0.96	0.83	0.50	
Incremental Delay, d2		41.7						30.4	1.5	27.3	0.2	
Delay (s)		75.6						58.4	26.7	52.6	3.8	
Level of Service		E						E	C	D	A	
Approach Delay (s)		75.6			0.0			43.1			33.5	
Approach LOS		E			A			D			C	

Intersection Summary			
HCM Average Control Delay	41.9	HCM Level of Service	D
HCM Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	93.8%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

23: E 191st Street & Gardner Rd

AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	20	80	850	20	100	640
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		5.0			5.0
Lane Util. Factor	1.00		1.00			1.00
Frt	0.89		1.00			1.00
Flt Protected	0.99		1.00			0.99
Satd. Flow (prot)	1639		1840			1843
Flt Permitted	0.99		1.00			0.77
Satd. Flow (perm)	1639		1840			1425
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	84	895	21	105	674
RTOR Reduction (vph)	78	0	1	0	0	0
Lane Group Flow (vph)	27	0	915	0	0	779
Heavy Vehicles (%)	0%	3%	3%	0%	5%	2%
Turn Type					Perm	
Protected Phases	8		2			6
Permitted Phases					6	
Actuated Green, G (s)	6.4		73.6			73.6
Effective Green, g (s)	6.4		73.6			73.6
Actuated g/C Ratio	0.07		0.82			0.82
Clearance Time (s)	5.0		5.0			5.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	117		1505			1165
v/s Ratio Prot	c0.02		0.50			
v/s Ratio Perm						c0.55
v/c Ratio	0.23		0.61			0.67
Uniform Delay, d1	39.5		3.0			3.3
Progression Factor	1.00		0.78			1.23
Incremental Delay, d2	1.0		0.6			2.9
Delay (s)	40.5		3.0			7.0
Level of Service	D		A			A
Approach Delay (s)	40.5		3.0			7.0
Approach LOS	D		A			A

Intersection Summary			
HCM Average Control Delay	6.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	103.7%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

24: Sunflower Road & US 56

AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	5	40	5	270	70	10	5	190	370	10	60	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.99			1.00			0.91			1.00	
Flt Protected		1.00			0.96			1.00			0.99	
Satd. Flow (prot)		1866			1764			1665			1635	
Flt Permitted		0.97			0.74			1.00			0.92	
Satd. Flow (perm)		1811			1358			1664			1522	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	5	42	5	284	74	11	5	200	389	11	63	0
RTOR Reduction (vph)	0	3	0	0	1	0	0	68	0	0	0	0
Lane Group Flow (vph)	0	49	0	0	368	0	0	526	0	0	74	0
Heavy Vehicles (%)	0%	0%	0%	4%	1%	0%	0%	6%	3%	0%	18%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		28.4			28.4			51.6			51.6	
Effective Green, g (s)		28.4			28.4			51.6			51.6	
Actuated g/C Ratio		0.32			0.32			0.57			0.57	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		571			429			954			873	
v/s Ratio Prot												
v/s Ratio Perm		0.03			c0.27			c0.32			0.05	
v/c Ratio		0.09			0.86			0.55			0.08	
Uniform Delay, d1		21.7			28.9			12.0			8.6	
Progression Factor		1.00			1.00			1.34			1.10	
Incremental Delay, d2		0.1			15.4			2.0			0.2	
Delay (s)		21.7			44.3			18.1			9.6	
Level of Service		C			D			B			A	
Approach Delay (s)		21.7			44.3			18.1			9.6	
Approach LOS		C			D			B			A	

Intersection Summary			
HCM Average Control Delay	26.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	67.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

25: US 56 & 4th Street

AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	480	130	90	250	110	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0			5.0	5.0	
Lane Util. Factor	1.00			1.00	1.00	
Frt	0.97			1.00	0.94	
Flt Protected	1.00			0.99	0.97	
Satd. Flow (prot)	1778			1782	1676	
Flt Permitted	1.00			0.74	0.97	
Satd. Flow (perm)	1778			1340	1676	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	505	137	95	263	116	95
RTOR Reduction (vph)	8	0	0	0	36	0
Lane Group Flow (vph)	634	0	0	358	175	0
Heavy Vehicles (%)	4%	3%	3%	6%	5%	2%
Turn Type			Perm			
Protected Phases	4			8	2	
Permitted Phases			8			
Actuated Green, G (s)	65.5			65.5	14.5	
Effective Green, g (s)	65.5			65.5	14.5	
Actuated g/C Ratio	0.73			0.73	0.16	
Clearance Time (s)	5.0			5.0	5.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	1294			975	270	
v/s Ratio Prot	c0.36				c0.10	
v/s Ratio Perm				0.27		
v/c Ratio	0.49			0.37	0.65	
Uniform Delay, d1	5.2			4.6	35.4	
Progression Factor	1.00			2.48	1.00	
Incremental Delay, d2	1.3			0.9	5.3	
Delay (s)	6.5			12.1	40.6	
Level of Service	A			B	D	
Approach Delay (s)	6.5			12.1	40.6	
Approach LOS	A			B	D	

Intersection Summary			
HCM Average Control Delay	14.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	75.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

26: 199th Street & Four Corners Road

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	5	420	360	130	120	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0		5.0	
Lane Util. Factor		1.00	1.00		1.00	
Frt		1.00	0.96		0.99	
Flt Protected		1.00	1.00		0.96	
Satd. Flow (prot)		1854	1474		921	
Flt Permitted		1.00	1.00		0.96	
Satd. Flow (perm)		1846	1474		921	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	5	442	379	137	126	11
RTOR Reduction (vph)	0	0	18	0	6	0
Lane Group Flow (vph)	0	447	498	0	131	0
Heavy Vehicles (%)	40%	2%	2%	86%	100%	40%
Turn Type	Perm					
Protected Phases		4	8		6	
Permitted Phases	4					
Actuated Green, G (s)		29.8	29.8		10.0	
Effective Green, g (s)		29.8	29.8		10.0	
Actuated g/C Ratio		0.60	0.60		0.20	
Clearance Time (s)		5.0	5.0		5.0	
Vehicle Extension (s)		3.0	3.0		3.0	
Lane Grp Cap (vph)		1105	882		185	
v/s Ratio Prot			c0.34		c0.14	
v/s Ratio Perm		0.24				
v/c Ratio		0.40	0.56		0.71	
Uniform Delay, d1		5.3	6.1		18.5	
Progression Factor		1.00	1.00		1.00	
Incremental Delay, d2		0.2	0.8		12.1	
Delay (s)		5.5	6.9		30.6	
Level of Service		A	A		C	
Approach Delay (s)		5.5	6.9		30.6	
Approach LOS		A	A		C	

Intersection Summary			
HCM Average Control Delay	9.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	49.8	Sum of lost time (s)	10.0
Intersection Capacity Utilization	42.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

27: 199th Street & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	170	10	30	150	450	10	260	20	290	90	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00		1.00		1.00	1.00	1.00
Frt	1.00	0.99		1.00	1.00	0.85		0.99		1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		1.00		0.95	1.00	1.00
Satd. Flow (prot)	1752	1783		1752	1845	1583		1830		1770	1863	1583
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.99		0.45	1.00	1.00
Satd. Flow (perm)	1752	1783		1752	1845	1583		1818		841	1863	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	42	179	11	32	158	474	11	274	21	305	95	53
RTOR Reduction (vph)	0	3	0	0	0	394	0	2	0	0	0	20
Lane Group Flow (vph)	42	187	0	32	158	80	0	304	0	305	95	33
Heavy Vehicles (%)	3%	6%	0%	3%	3%	2%	0%	3%	0%	2%	2%	2%
Turn Type	Prot			Prot		Perm	Perm			pm+pt		Perm
Protected Phases	5	2		1	6			8		7	4	
Permitted Phases						6	8			4		4
Actuated Green, G (s)	4.4	14.7		4.9	15.2	15.2		38.0		55.4	55.4	55.4
Effective Green, g (s)	4.4	14.7		4.9	15.2	15.2		38.0		55.4	55.4	55.4
Actuated g/C Ratio	0.05	0.16		0.05	0.17	0.17		0.42		0.62	0.62	0.62
Clearance Time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	86	291		95	312	267		768		646	1147	974
v/s Ratio Prot	0.02	c0.11		0.02	c0.09					c0.07	0.05	
v/s Ratio Perm						0.05		0.17		c0.23		0.02
v/c Ratio	0.49	0.64		0.34	0.51	0.30		0.40		0.47	0.08	0.03
Uniform Delay, d1	41.7	35.2		41.0	34.0	32.7		18.0		9.3	7.0	6.8
Progression Factor	0.92	1.03		1.00	1.00	1.00		1.00		1.46	1.33	2.18
Incremental Delay, d2	4.3	4.8		2.1	1.3	0.6		1.5		0.4	0.1	0.0
Delay (s)	42.9	41.0		43.1	35.3	33.4		19.6		14.0	9.5	14.8
Level of Service	D	D		D	D	C		B		B	A	B
Approach Delay (s)		41.3			34.3			19.6			13.1	
Approach LOS		D			C			B			B	

Intersection Summary			
HCM Average Control Delay	26.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	61.1%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

30: US-56 & I-35 NB Loop

AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	1330	1630	0	1780	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	1400	1716	0	1874	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked					0.62	
vC, conflicting volume			3116		2337	700
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			3116		1922	700
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			105		37	386

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	700	700	1716	937	937
Volume Left	0	0	0	0	0
Volume Right	0	0	1716	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.41	0.41	1.01	0.55	0.55
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	104.3%	ICU Level of Service	G
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

37: 199th Street & West Waverley

AM Peak Hour

Movement	EBL	EBT	WBU	WBT	WBR	SBL	SBR
Lane Configurations							
Volume (vph)	10	790	0	740	130	100	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0		5.0	
Lane Util. Factor	1.00	1.00		1.00		1.00	
Frt	1.00	1.00		0.98		0.99	
Flt Protected	0.95	1.00		1.00		0.96	
Satd. Flow (prot)	1805	1624		1621		1234	
Flt Permitted	0.22	1.00		1.00		0.96	
Satd. Flow (perm)	422	1624		1621		1234	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	859	0	804	141	109	11
RTOR Reduction (vph)	0	0	0	6	0	4	0
Lane Group Flow (vph)	11	859	0	939	0	116	0
Heavy Vehicles (%)	0%	17%	2%	17%	1%	50%	0%
Turn Type	Perm		Perm				
Protected Phases		4		8		6	
Permitted Phases	4		8				
Actuated Green, G (s)	67.2	67.2		67.2		12.8	
Effective Green, g (s)	67.2	67.2		67.2		12.8	
Actuated g/C Ratio	0.75	0.75		0.75		0.14	
Clearance Time (s)	5.0	5.0		5.0		5.0	
Vehicle Extension (s)	3.0	3.0		3.0		3.0	
Lane Grp Cap (vph)	315	1213		1210		176	
v/s Ratio Prot		0.53		c0.58		c0.09	
v/s Ratio Perm	0.03						
v/c Ratio	0.03	0.71		0.78		0.66	
Uniform Delay, d1	3.0	6.1		6.9		36.5	
Progression Factor	1.00	1.00		0.84		1.00	
Incremental Delay, d2	0.2	3.5		3.6		8.6	
Delay (s)	3.2	9.6		9.3		45.1	
Level of Service	A	A		A		D	
Approach Delay (s)		9.6		9.3		45.1	
Approach LOS		A		A		D	

Intersection Summary			
HCM Average Control Delay	11.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	61.3%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

38: 199th Street & IH-35 SB Ramp

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	830	70	50	300	0	0	0	0	10	0	570
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		1.00		1.00	1.00					1.00		1.00
Frt		0.99		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		1566		1770	1827					1805		1346
Flt Permitted		1.00		0.18	1.00					0.95		1.00
Satd. Flow (perm)		1566		332	1827					1805		1346
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	902	76	54	326	0	0	0	0	11	0	620
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	586
Lane Group Flow (vph)	0	976	0	54	326	0	0	0	0	11	0	34
Heavy Vehicles (%)	0%	21%	9%	2%	4%	0%	0%	0%	0%	0%	0%	20%
Turn Type				pm+pt						Prot		custom
Protected Phases		4		3	8					6		
Permitted Phases				8								6
Actuated Green, G (s)		65.2		75.0	75.0					5.0		5.0
Effective Green, g (s)		65.2		75.0	75.0					5.0		5.0
Actuated g/C Ratio		0.72		0.83	0.83					0.06		0.06
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		1134		353	1523					100		75
v/s Ratio Prot		c0.62		0.01	c0.18					0.01		
v/s Ratio Perm				0.12								c0.03
v/c Ratio		0.86		0.15	0.21					0.11		0.46
Uniform Delay, d1		9.1		6.6	1.5					40.4		41.2
Progression Factor		0.96		1.86	1.94					1.00		1.00
Incremental Delay, d2		6.4		0.2	0.1					0.5		4.4
Delay (s)		15.1		12.5	3.0					40.9		45.6
Level of Service		B		B	A					D		D
Approach Delay (s)		15.1			4.4			0.0			45.5	
Approach LOS		B			A			A			D	

Intersection Summary			
HCM Average Control Delay	22.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	74.3%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

39: 199th Street & IH-35 NB Ramp

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	750	90	0	0	140	20	210	0	90	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0		5.0			
Lane Util. Factor	1.00	1.00			1.00		1.00		1.00			
Frt	1.00	1.00			0.98		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1467	1759			1805		1752		1583			
Flt Permitted	0.43	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	671	1759			1805		1752		1583			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	815	98	0	0	152	22	228	0	98	0	0	0
RTOR Reduction (vph)	0	0	0	0	6	0	0	0	82	0	0	0
Lane Group Flow (vph)	815	98	0	0	168	0	228	0	16	0	0	0
Heavy Vehicles (%)	23%	8%	0%	0%	4%	0%	3%	0%	2%	0%	0%	0%
Turn Type	pm+pt						custom		custom			
Protected Phases	7	4			8							
Permitted Phases	4						2		2			
Actuated Green, G (s)	64.9	64.9			18.3		15.1		15.1			
Effective Green, g (s)	64.9	64.9			18.3		15.1		15.1			
Actuated g/C Ratio	0.72	0.72			0.20		0.17		0.17			
Clearance Time (s)	5.0	5.0			5.0		5.0		5.0			
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Lane Grp Cap (vph)	852	1268			367		294		266			
v/s Ratio Prot	c0.44	0.06			0.09							
v/s Ratio Perm	c0.25						c0.13		0.01			
v/c Ratio	0.96	0.08			0.46		0.78		0.06			
Uniform Delay, d1	11.9	3.7			31.5		35.8		31.5			
Progression Factor	0.57	0.14			0.53		1.00		1.00			
Incremental Delay, d2	13.2	0.1			0.9		12.1		0.1			
Delay (s)	20.0	0.6			17.7		47.9		31.6			
Level of Service	C	A			B		D		C			
Approach Delay (s)		17.9			17.7			43.0			0.0	
Approach LOS		B			B			D			A	

Intersection Summary			
HCM Average Control Delay	23.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	74.3%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

40: 199th Street & East Waverley

AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	160	10	5	150	10	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	174	11	5	163	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	820					
pX, platoon unblocked						
vC, conflicting volume			185		353	179
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			185		353	179
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	99
cM capacity (veh/h)			1402		646	869

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	185	168	16
Volume Left	0	5	11
Volume Right	11	0	5
cSH	1700	1402	706
Volume to Capacity	0.11	0.00	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.3	10.2
Lane LOS		A	B
Approach Delay (s)	0.0	0.3	10.2
Approach LOS			B

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	21.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

80: 191st Street & Driveway A

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	110	20	10	5	60	120
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	120	22	11	5	65	130
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	16				274	14
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	16				274	14
tC, single (s)	5.1				7.4	7.2
tC, 2 stage (s)						
tF (s)	3.1				4.4	4.2
p0 queue free %	90				87	84
cM capacity (veh/h)	1143				491	841

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	141	16	65	130
Volume Left	120	0	65	0
Volume Right	0	5	0	130
cSH	1143	1700	491	841
Volume to Capacity	0.10	0.01	0.13	0.16
Queue Length 95th (ft)	9	0	11	14
Control Delay (s)	7.3	0.0	13.5	10.1
Lane LOS	A		B	B
Approach Delay (s)	7.3	0.0	11.2	
Approach LOS			B	

Intersection Summary			
Average Delay	9.1		
Intersection Capacity Utilization	23.8%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner IMF Operations - (Improved + Mitigated) - AM Peak Hour - Synchro Intersection LOS

82: Driveway C & Waverly Road

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	60	50	60	190	140	50
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	65	54	65	207	152	54
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	516	179	207			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	516	179	207			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	87	94	95			
cM capacity (veh/h)	498	869	1377			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	65	54	272	207
Volume Left	65	0	65	0
Volume Right	0	54	0	54
cSH	498	869	1377	1700
Volume to Capacity	0.13	0.06	0.05	0.12
Queue Length 95th (ft)	11	5	4	0
Control Delay (s)	13.3	9.4	2.2	0.0
Lane LOS	B	A	A	
Approach Delay (s)	11.5		2.2	0.0
Approach LOS	B			

Intersection Summary			
Average Delay	3.3		
Intersection Capacity Utilization	37.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study 2030 Gardner Proposed Action - (Improved+Mitigated)
AM Peak Hour

84: 191st Street & Driveway E

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	70	10	20	30	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	76	11	22	33	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	33				120	22
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	33				120	22
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				96	99
cM capacity (veh/h)	1592				875	1061

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	87	33	38
Volume Left	11	0	33
Volume Right	0	22	5
cSH	1592	1700	897
Volume to Capacity	0.01	0.02	0.04
Queue Length 95th (ft)	1	0	3
Control Delay (s)	1.0	0.0	9.2
Lane LOS	A		A
Approach Delay (s)	1.0	0.0	9.2
Approach LOS			A

Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	20.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
1: 175th Street & Waverly Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Volume (vph)	50	10	390	10	20	30	700	270	10	10	180	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.91		1.00	0.99		1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1659		1805	1819		1770	3522		1805	3437	
Flt Permitted	0.72	1.00		0.38	1.00		0.61	1.00		0.57	1.00	
Satd. Flow (perm)	1346	1659		724	1819		1132	3522		1086	3437	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	53	11	411	11	21	32	737	284	11	11	189	42
RTOR Reduction (vph)	0	363	0	0	28	0	0	2	0	0	14	0
Lane Group Flow (vph)	53	59	0	11	25	0	737	293	0	11	217	0
Heavy Vehicles (%)	2%	0%	3%	0%	0%	0%	2%	2%	0%	0%	2%	3%
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	10.5	10.5		10.5	10.5		69.5	61.2		46.4	43.1	
Effective Green, g (s)	10.5	10.5		10.5	10.5		69.5	61.2		46.4	43.1	
Actuated g/C Ratio	0.12	0.12		0.12	0.12		0.77	0.68		0.52	0.48	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	157	194		84	212		1026	2395		586	1646	
v/s Ratio Prot		0.04			0.01		c0.17	0.08		0.00	0.06	
v/s Ratio Perm	c0.04			0.02			c0.38			0.01		
v/c Ratio	0.34	0.30		0.13	0.12		0.72	0.12		0.02	0.13	
Uniform Delay, d1	36.6	36.4		35.7	35.6		6.7	5.0		10.6	13.0	
Progression Factor	1.00	1.00		1.00	1.00		0.53	0.87		1.00	1.00	
Incremental Delay, d2	1.3	0.9		0.7	0.2		2.0	0.1		0.0	0.2	
Delay (s)	37.8	37.3		36.4	35.8		5.6	4.4		10.6	13.2	
Level of Service	D	D		D	D		A	A		B	B	
Approach Delay (s)		37.4			35.9			5.3			13.1	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM Average Control Delay	15.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	81.0%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
2: US 56 & Gardner Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↑	↱	↰	↑↑	↱	↰↰	↑↱	
Volume (vph)	140	450	60	310	900	390	50	870	220	320	890	130
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3519	1583	1770	3689	1583	1770	3689	1568	3400	3438	
Flt Permitted	0.16	1.00	1.00	0.38	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	297	3519	1583	702	3689	1583	1770	3689	1568	3400	3438	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	147	474	63	326	947	411	53	916	232	337	937	137
RTOR Reduction (vph)	0	0	45	0	0	230	0	0	157	0	12	0
Lane Group Flow (vph)	147	474	18	326	947	181	53	916	75	337	1062	0
Heavy Vehicles (%)	2%	8%	2%	2%	3%	2%	2%	3%	3%	3%	3%	3%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			
Actuated Green, G (s)	31.8	25.1	25.1	34.0	26.2	26.2	3.9	29.1	29.1	11.3	36.5	
Effective Green, g (s)	31.8	25.1	25.1	34.0	26.2	26.2	3.9	29.1	29.1	11.3	36.5	
Actuated g/C Ratio	0.35	0.28	0.28	0.38	0.29	0.29	0.04	0.32	0.32	0.13	0.41	
Clearance Time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	215	981	441	358	1074	461	77	1193	507	427	1394	
v/s Ratio Prot	0.05	0.13		c0.08	0.26		c0.03	c0.25		c0.10	0.31	
v/s Ratio Perm	0.19		0.01	c0.27		0.11			0.05			
v/c Ratio	0.68	0.48	0.04	0.91	0.88	0.39	0.69	0.77	0.15	0.79	0.76	
Uniform Delay, d1	22.5	27.0	23.7	24.6	30.4	25.5	42.5	27.4	21.6	38.2	23.0	
Progression Factor	1.35	0.67	0.40	1.32	1.15	2.01	0.73	0.56	0.30	1.00	1.00	
Incremental Delay, d2	8.6	1.7	0.2	20.7	7.8	1.8	14.1	1.8	0.1	9.4	2.5	
Delay (s)	39.0	19.9	9.7	53.1	42.7	53.1	45.2	17.1	6.7	47.6	25.5	
Level of Service	D	B	A	D	D	D	D	B	A	D	C	
Approach Delay (s)		23.1			47.3			16.3			30.8	
Approach LOS		C			D			B			C	

Intersection Summary			
HCM Average Control Delay	31.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.8
Intersection Capacity Utilization	79.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
3: US 56 & Elm — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱			↰↑↱		↰	↱		↰	↱	
Volume (vph)	10	980	30	40	1610	40	20	10	50	100	20	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			1.00		1.00	0.88		1.00	0.91	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3425			3521		1719	1637		1770	1697	
Flt Permitted		0.93			0.90		0.72	1.00		0.72	1.00	
Satd. Flow (perm)		3176			3157		1307	1637		1332	1697	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	11	1032	32	42	1695	42	21	11	53	105	21	32
RTOR Reduction (vph)	0	2	0	0	1	0	0	47	0	0	25	0
Lane Group Flow (vph)	0	1073	0	0	1778	0	21	17	0	105	28	0
Heavy Vehicles (%)	0%	5%	3%	3%	2%	3%	5%	0%	2%	2%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		70.0			70.0		11.0	11.0		11.0	11.0	
Effective Green, g (s)		70.0			70.0		11.0	11.0		11.0	11.0	
Actuated g/C Ratio		0.78			0.78		0.12	0.12		0.12	0.12	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2470			2455		160	200		163	207	
v/s Ratio Prot								0.01			0.02	
v/s Ratio Perm		0.34			c0.56		0.02			c0.08		
v/c Ratio		0.43			0.72		0.13	0.09		0.64	0.13	
Uniform Delay, d1		3.4			5.1		35.2	35.0		37.6	35.2	
Progression Factor		0.42			1.24		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.5			1.4		0.4	0.2		8.4	0.3	
Delay (s)		1.9			7.7		35.6	35.2		46.1	35.5	
Level of Service		A			A		D	D		D	D	
Approach Delay (s)		1.9			7.7			35.3			42.5	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	8.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	94.2%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
4: US 56 & Mulberry — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱			↰↑↱		↰	↱		↰	↱	
Volume (vph)	20	1110	10	30	1720	40	10	5	20	40	10	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			1.00		1.00	0.88		1.00	0.90	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3435			3523		1805	1605		1752	1713	
Flt Permitted		0.89			0.91		0.74	1.00		0.74	1.00	
Satd. Flow (perm)		3045			3211		1399	1605		1366	1713	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	1168	11	32	1811	42	11	5	21	42	11	21
RTOR Reduction (vph)	0	1	0	0	1	0	0	19	0	0	19	0
Lane Group Flow (vph)	0	1199	0	0	1884	0	11	7	0	42	13	0
Heavy Vehicles (%)	0%	5%	0%	3%	2%	3%	0%	0%	5%	3%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		73.8			73.8		7.2	7.2		7.2	7.2	
Effective Green, g (s)		73.8			73.8		7.2	7.2		7.2	7.2	
Actuated g/C Ratio		0.82			0.82		0.08	0.08		0.08	0.08	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2497			2633		112	128		109	137	
v/s Ratio Prot								0.00			0.01	
v/s Ratio Perm		0.39			c0.59		0.01			c0.03		
v/c Ratio		0.48			0.72		0.10	0.05		0.39	0.09	
Uniform Delay, d1		2.4			3.5		38.4	38.2		39.3	38.4	
Progression Factor		0.39			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.6			0.9		0.4	0.2		2.3	0.3	
Delay (s)		1.6			4.5		38.8	38.4		41.6	38.7	
Level of Service		A			A		D	D		D	D	
Approach Delay (s)		1.6			4.5			38.5			40.3	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	4.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	86.6%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner IMF Operations - (Improved) - PM Peak Hour - Synchro Intersection LOS

5: US 56 & Moonlight Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	150	770	250	380	1500	1300	200	550	160	730	720	160
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1736	3585	1583	1770	3725	1583	1770	3725	1583	3433	3539	1553
Flt Permitted	0.09	1.00	1.00	0.18	1.00	1.00	0.28	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	172	3585	1583	333	3725	1583	514	3725	1583	3433	3539	1553
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	158	811	263	400	1579	1368	211	579	168	768	758	168
RTOR Reduction (vph)	0	0	124	0	0	227	0	0	116	0	0	93
Lane Group Flow (vph)	158	811	139	400	1579	1141	211	579	52	768	758	75
Heavy Vehicles (%)	4%	6%	2%	2%	2%	2%	2%	2%	2%	2%	2%	4%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		custom	Prot		Perm
Protected Phases	5	2		1	6		3	8	8	7	4	
Permitted Phases	2		2	6		6	8		8			4
Actuated Green, G (s)	48.4	42.4	42.4	69.5	58.0	58.0	23.0	14.5	14.5	18.5	24.5	24.5
Effective Green, g (s)	48.4	42.4	42.4	69.5	58.0	58.0	23.0	14.5	14.5	18.5	24.5	24.5
Actuated g/C Ratio	0.40	0.35	0.35	0.58	0.48	0.48	0.19	0.12	0.12	0.15	0.20	0.20
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	148	1267	559	452	1800	765	187	450	191	529	723	317
v/s Ratio Prot	0.05	0.23		c0.16	0.42		0.08	c0.16	0.03	c0.22	0.21	
v/s Ratio Perm	0.38		0.09	0.35		c0.72	0.14					0.05
v/c Ratio	1.07	0.64	0.25	0.88	0.88	1.49	1.13	1.29	0.27	1.45	1.05	0.24
Uniform Delay, d1	31.1	32.4	27.5	23.6	27.8	31.0	46.8	52.8	48.0	50.7	47.8	39.9
Progression Factor	1.00	1.00	1.00	1.01	0.86	0.90	0.89	0.87	0.65	1.00	1.00	1.00
Incremental Delay, d2	93.1	2.5	1.1	5.2	1.7	223.0	101.1	143.5	0.3	213.7	46.9	0.1
Delay (s)	124.2	34.9	28.6	29.1	25.7	250.9	142.8	189.6	31.3	264.5	94.6	40.1
Level of Service	F	C	C	C	C	F	F	F	C	F	F	D
Approach Delay (s)		45.0			118.1			151.5			166.2	
Approach LOS		D			F			F			F	

Intersection Summary			
HCM Average Control Delay	121.4	HCM Level of Service	F
HCM Volume to Capacity ratio	1.44		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	117.8%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

6: Old US 56 & US 56

Movement	NBL	NBR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	700	130	1360	300	10	2480
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	0.97	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	3400	1599	3654	1553	1805	3725
Flt Permitted	0.95	1.00	1.00	1.00	0.12	1.00
Satd. Flow (perm)	3400	1599	3654	1553	230	3725
Peak-hour factor, PHF	0.97	0.97	0.95	0.95	0.95	0.95
Adj. Flow (vph)	722	134	1432	316	11	2611
RTOR Reduction (vph)	0	83	0	42	0	0
Lane Group Flow (vph)	722	51	1432	274	11	2611
Heavy Vehicles (%)	3%	1%	4%	4%	0%	2%
Turn Type		Perm		pm+ov	pm+pt	
Protected Phases	8		2	8	1	6
Permitted Phases		8	2	2	6	6
Actuated Green, G (s)	25.0	25.0	79.2	104.2	85.0	85.0
Effective Green, g (s)	25.0	25.0	79.2	104.2	85.0	85.0
Actuated g/C Ratio	0.21	0.21	0.66	0.87	0.71	0.71
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	708	333	2412	1413	173	2639
v/s Ratio Prot	c0.21		0.39	0.04	0.00	c0.70
v/s Ratio Perm		0.03		0.14	0.04	
v/c Ratio	1.02	0.15	0.59	0.19	0.06	0.99
Uniform Delay, d1	47.5	38.8	11.4	1.3	8.9	17.1
Progression Factor	1.00	1.00	1.43	4.22	0.70	0.57
Incremental Delay, d2	38.9	0.2	0.3	0.0	0.1	11.2
Delay (s)	86.4	39.1	16.6	5.3	6.3	20.9
Level of Service	F	D	B	A	A	C
Approach Delay (s)	79.0		14.6			20.8
Approach LOS	E		B			C

Intersection Summary			
HCM Average Control Delay	28.3	HCM Level of Service	C
HCM Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	93.4%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

7: US-56 & Cedar Niles

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	60	2100	190	800	2020	60	210	20	850	60	20	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2	5.2	5.2	5.2	5.2
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00	1.00	1.00	0.88	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3689	1583	3433	3689	1583	1770	2000	2787	1770	2000	1568
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.74	1.00	1.00	0.74	1.00	1.00
Satd. Flow (perm)	1770	3689	1583	3433	3689	1583	1385	2000	2787	1385	2000	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	63	2211	200	842	2126	63	221	21	895	63	21	42
RTOR Reduction (vph)	0	0	77	0	0	18	0	0	0	0	0	38
Lane Group Flow (vph)	63	2211	123	842	2126	45	221	21	895	63	21	4
Heavy Vehicles (%)	2%	3%	2%	2%	3%	2%	2%	0%	2%	2%	0%	3%
Turn Type	Prot		Perm	Prot		Perm	Perm		pt+ov	Perm		Perm
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases			2			6	8			4		4
Actuated Green, G (s)	5.6	68.8	68.8	23.0	86.2	86.2	12.6	12.6	40.8	12.6	12.6	12.6
Effective Green, g (s)	5.6	68.8	68.8	23.0	86.2	86.2	12.6	12.6	40.8	12.6	12.6	12.6
Actuated g/C Ratio	0.05	0.57	0.57	0.19	0.72	0.72	0.10	0.10	0.34	0.10	0.10	0.10
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2		5.2	5.2	5.2
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lane Grp Cap (vph)	83	2115	908	658	2650	1137	145	210	948	145	210	165
v/s Ratio Prot	0.04	c0.60		c0.25	0.58			0.01	0.32		0.01	
v/s Ratio Perm			0.08			0.03	c0.16			0.05		0.00
v/c Ratio	0.76	1.05	0.14	1.28	0.80	0.04	1.52	0.10	0.94	0.43	0.10	0.03
Uniform Delay, d1	56.5	25.6	11.8	48.5	11.2	4.9	53.7	48.6	38.5	50.4	48.6	48.2
Progression Factor	0.82	0.56	0.01	1.08	1.02	1.08	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	28.0	32.3	0.3	127.0	0.2	0.0	267.7	0.1	17.0	0.8	0.1	0.0
Delay (s)	74.2	46.7	0.4	179.3	11.7	5.3	321.4	48.6	55.5	51.1	48.6	48.2
Level of Service	E	D	A	F	B	A	F	D	E	D	D	D
Approach Delay (s)		43.6			58.1			107.1			49.7	
Approach LOS		D			E			F			D	

Intersection Summary			
HCM Average Control Delay	60.9	HCM Level of Service	E
HCM Volume to Capacity ratio	1.15		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.6
Intersection Capacity Utilization	109.3%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

8: US-56 & I-35 SB Ramps

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	2700	280	650	1260	0	0	0	0	150	0	1580
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		0.99		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3486		1736	3725					1770		2787
Flt Permitted		1.00		0.23	1.00					0.95		1.00
Satd. Flow (perm)		3486		415	3725					1770		2787
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2842	295	684	1326	0	0	0	0	158	0	1663
RTOR Reduction (vph)	0	7	0	0	0	0	0	0	0	0	0	7
Lane Group Flow (vph)	0	3131	0	684	1326	0	0	0	0	158	0	1656
Heavy Vehicles (%)	0%	2%	3%	4%	2%	0%	0%	0%	0%	2%	0%	2%
Turn Type				pm+pt						custom		custom
Protected Phases		2		1	6					4		5
Permitted Phases				6						4		4
Actuated Green, G (s)		68.0		44.6	44.6					10.0		60.4
Effective Green, g (s)		68.0		44.6	44.6					10.0		60.4
Actuated g/C Ratio		0.57		0.37	0.37					0.08		0.50
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		1975		451	1384					148		1519
v/s Ratio Prot		c0.90		c0.34	0.36					0.09		c0.46
v/s Ratio Perm				0.22								0.14
v/c Ratio		1.59		1.52	0.96					1.07		1.09
Uniform Delay, d1		26.0		34.2	36.8					55.0		29.8
Progression Factor		0.76		0.92	0.89					1.00		1.00
Incremental Delay, d2		263.5		240.2	11.5					93.1		51.7
Delay (s)		283.2		271.6	44.2					148.1		81.5
Level of Service		F		F	D					F		F
Approach Delay (s)		283.2			121.6			0.0			87.3	
Approach LOS		F			F			A			F	

Intersection Summary			
HCM Average Control Delay	185.4	HCM Level of Service	F
HCM Volume to Capacity ratio	1.48		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	139.5%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

9: US-56 & I-35 NB Ramps

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1530	0	0	1820	570	100	0	390	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95	0.95			
Frt		1.00			1.00	0.85	1.00	0.85	0.85			
Flt Protected		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (prot)		3725			3539	1538	1703	1408	1408			
Flt Permitted		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (perm)		3725			3539	1538	1703	1408	1408			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1611	0	0	1916	600	105	0	411	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	80	0	0	0	0	0	0
Lane Group Flow (vph)	0	1611	0	0	1916	520	105	206	205	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	5%	6%	0%	9%	0%	0%	0%
Turn Type						Perm	Perm		Perm			
Protected Phases		2			6			8				
Permitted Phases						6	8		8			
Actuated Green, G (s)		86.6			86.6	86.6	23.4	23.4	23.4			
Effective Green, g (s)		86.6			86.6	86.6	23.4	23.4	23.4			
Actuated g/C Ratio		0.72			0.72	0.72	0.19	0.19	0.19			
Clearance Time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0	3.0			
Lane Grp Cap (vph)		2688			2554	1110	332	275	275			
v/s Ratio Prot		0.43			c0.54			c0.15				
v/s Ratio Perm						0.34	0.06		0.15			
v/c Ratio		0.60			0.75	0.47	0.32	0.75	0.75			
Uniform Delay, d1		8.2			10.1	7.0	41.4	45.5	45.5			
Progression Factor		0.38			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2		0.1			1.3	0.3	0.6	10.6	10.5			
Delay (s)		3.2			11.4	7.3	42.0	56.2	56.0			
Level of Service		A			B	A	D	E	E			
Approach Delay (s)		3.2			10.4			53.2			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	12.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	85.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

10: Santa Fe & Moonlight Road

PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	250	480	440	160	380	930
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.96		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3398		1770	3539
Flt Permitted	0.95	1.00	1.00		0.37	1.00
Satd. Flow (perm)	1770	1583	3398		698	3539
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	263	505	463	168	400	979
RTOR Reduction (vph)	0	405	18	0	0	0
Lane Group Flow (vph)	263	100	613	0	400	979
Turn Type		Perm			pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8			6	
Actuated Green, G (s)	23.8	23.8	68.4		86.2	86.2
Effective Green, g (s)	23.8	23.8	68.4		86.2	86.2
Actuated g/C Ratio	0.20	0.20	0.57		0.72	0.72
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	351	314	1937		616	2542
v/s Ratio Prot	c0.15		0.18		c0.07	0.28
v/s Ratio Perm		0.06			c0.40	
v/c Ratio	0.75	0.32	0.32		0.65	0.39
Uniform Delay, d1	45.3	41.2	13.5		14.2	6.6
Progression Factor	1.00	1.00	1.00		0.80	0.94
Incremental Delay, d2	8.5	0.6	0.4		1.2	0.2
Delay (s)	53.8	41.8	14.0		12.6	6.4
Level of Service	D	D	B		B	A
Approach Delay (s)	45.9		14.0			8.2
Approach LOS	D		B			A

Intersection Summary			
HCM Average Control Delay	19.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

11: Waverly Road & US 56

PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	20	310	80	300	240	30	40	100	20	100	160	620
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95		1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.98		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1805	3539	1524	3400	3461		1752	3195	1615	1687	3406	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1805	3539	1524	3400	3461		1752	3195	1615	1687	3406	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	326	84	316	253	32	42	105	21	105	168	653
RTOR Reduction (vph)	0	0	72	0	12	0	0	0	15	0	0	401
Lane Group Flow (vph)	21	326	12	316	273	0	42	105	6	105	168	252
Heavy Vehicles (%)	0%	2%	6%	3%	2%	7%	3%	13%	0%	7%	6%	2%
Turn Type	Prot		Perm	Prot			Prot		Perm	Prot		Perm
Protected Phases	3	8		7	4		5	2		1	6	
Permitted Phases			8					2	2			6
Actuated Green, G (s)	2.2	13.3	13.3	16.6	27.7		5.3	26.2	26.2	13.9	34.8	34.8
Effective Green, g (s)	2.2	13.3	13.3	16.6	27.7		5.3	26.2	26.2	13.9	34.8	34.8
Actuated g/C Ratio	0.02	0.15	0.15	0.18	0.31		0.06	0.29	0.29	0.15	0.39	0.39
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	44	523	225	627	1065		103	930	470	261	1317	612
v/s Ratio Prot	0.01	c0.09		c0.09	0.08		0.02	0.03		c0.06	0.05	
v/s Ratio Perm			0.01						0.00			c0.16
v/c Ratio	0.48	0.62	0.06	0.50	0.26		0.41	0.11	0.01	0.40	0.13	0.41
Uniform Delay, d1	43.3	36.0	33.0	33.0	23.4		40.8	23.4	22.7	34.3	17.8	20.1
Progression Factor	1.00	1.00	1.00	0.87	0.84		0.91	0.96	0.98	1.51	0.33	2.65
Incremental Delay, d2	7.9	2.3	0.1	0.6	0.1		2.6	0.2	0.0	0.6	0.1	1.1
Delay (s)	51.3	38.3	33.1	29.4	19.8		39.9	22.8	22.2	52.4	6.0	54.6
Level of Service	D	D	C	C	B		D	C	C	D	A	D
Approach Delay (s)		37.9			24.9			27.0			45.5	
Approach LOS		D			C			C			D	

Intersection Summary			
HCM Average Control Delay	36.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	62.8%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

12: 183rd Street & Four Corners Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	50	5	0	30	5	5	50	0	5	20	5
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	53	5	0	32	5	5	53	0	5	21	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	63	37	58	32
Volume Left (vph)	5	0	5	5
Volume Right (vph)	5	5	0	5
Hadj (s)	0.00	-0.04	0.05	-0.01
Departure Headway (s)	4.1	4.1	4.2	4.2
Degree Utilization, x	0.07	0.04	0.07	0.04
Capacity (veh/h)	848	849	827	838
Control Delay (s)	7.5	7.3	7.5	7.3
Approach Delay (s)	7.5	7.3	7.5	7.3
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.4		
HCM Level of Service	A		
Intersection Capacity Utilization	17.2%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner IMF Operations - (Improved) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study | 2030 Gardner Proposed Action - (Improved)
13: 183rd Street & US 56 | PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	50	0	0	120	160	30
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	53	0	0	126	168	32
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	311	184	200			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	311	184	200			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	92	100	100			
cM capacity (veh/h)	682	863	1384			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	53	126	200
Volume Left	53	0	0
Volume Right	0	0	32
cSH	682	1384	1700
Volume to Capacity	0.08	0.00	0.12
Queue Length 95th (ft)	6	0	0
Control Delay (s)	10.7	0.0	0.0
Lane LOS	B		
Approach Delay (s)	10.7	0.0	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	20.2%	ICU Level of Service	A
Analysis Period (min)	15		

HDR Engineering, Inc. 4/30/2008

BNSF NEPA Traffic Study | 2030 Gardner Proposed Action - (Improved)
14: 183rd Street & Waverly Road | PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	5	260	150	10	160	190
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	274	158	11	168	200
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	700	163			168	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	700	163			168	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	69			88	
cM capacity (veh/h)	360	887			1421	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	279	168	368
Volume Left	5	0	168
Volume Right	274	11	0
cSH	863	1700	1421
Volume to Capacity	0.32	0.10	0.12
Queue Length 95th (ft)	35	0	10
Control Delay (s)	11.2	0.0	4.2
Lane LOS	B		A
Approach Delay (s)	11.2	0.0	4.2
Approach LOS	B		

Intersection Summary			
Average Delay	5.7		
Intersection Capacity Utilization	53.7%	ICU Level of Service	A
Analysis Period (min)	15		

HDR Engineering, Inc. 4/30/2008

BNSF NEPA Traffic Study | 2030 Gardner Proposed Action - (Improved)
15: 183rd Street & Gardner Road | PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	130	120	160	170	140	90	200	960	280	130	930	120
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.91		1.00	0.94		1.00	0.97		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1713		1770	1764		1787	3394		1770	3449	
Flt Permitted	0.51	1.00		0.21	1.00		0.19	1.00		0.11	1.00	
Satd. Flow (perm)	956	1713		396	1764		364	3394		211	3449	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	126	168	179	147	95	211	1011	295	137	979	126
RTOR Reduction (vph)	0	54	0	0	0	0	0	30	0	0	11	0
Lane Group Flow (vph)	137	240	0	179	242	0	211	1276	0	137	1094	0
Heavy Vehicles (%)	2%	2%	1%	2%	1%	2%	1%	3%	2%	2%	3%	2%
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	21.1	15.1		28.5	18.8		40.3	40.3		40.2	40.2	
Effective Green, g (s)	21.1	15.1		28.5	18.8		40.3	40.3		40.2	40.2	
Actuated g/C Ratio	0.23	0.17		0.32	0.21		0.45	0.45		0.45	0.45	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	278	287		273	368		242	1520		179	1541	
v/s Ratio Prot	0.03	c0.14		c0.07	0.14		0.05	c0.38		0.04	c0.32	
v/s Ratio Perm	0.08			0.14			c0.34			0.30		
v/c Ratio	0.49	0.84		0.66	0.66		0.87	0.84		0.77	0.71	
Uniform Delay, d1	28.6	36.3		24.5	32.6		28.2	22.0		20.7	20.2	
Progression Factor	1.21	1.13		1.00	1.00		1.00	1.00		0.83	0.87	
Incremental Delay, d2	1.4	18.6		5.6	4.2		27.2	5.7		11.7	1.8	
Delay (s)	35.9	59.6		30.1	36.9		55.5	27.7		29.0	19.4	
Level of Service	D	E		C	D		E	C		C	B	
Approach Delay (s)		52.1			34.0			31.6			20.5	
Approach LOS		D			C			C			C	

Intersection Summary			
HCM Average Control Delay	30.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	25.0
Intersection Capacity Utilization	84.9%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

HDR Engineering, Inc. 4/30/2008

BNSF NEPA Traffic Study | 2030 Gardner Proposed Action - (Improved)
16: Four Corners Road & US 56 | PM Peak Hour

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	0	20	50	130	170	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	0	21	53	137	179	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	421	179	179			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	421	179	179			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	98	96			
cM capacity (veh/h)	571	869	1397			

Direction, Lane #	SB 1	NE 1	SW 1
Volume Total	21	189	179
Volume Left	0	53	0
Volume Right	21	0	0
cSH	869	1397	1700
Volume to Capacity	0.02	0.04	0.11
Queue Length 95th (ft)	2	3	0
Control Delay (s)	9.2	2.4	0.0
Lane LOS	A	A	
Approach Delay (s)	9.2	2.4	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	31.9%	ICU Level of Service	A
Analysis Period (min)	15		

HDR Engineering, Inc. 4/30/2008

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
17: 191st Street & US 56 — PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	50	5	5	120	170	30
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	53	5	5	126	179	32
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	332	195	211			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	332	195	211			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	92	99	100			
cM capacity (veh/h)	661	852	1372			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	58	132	211
Volume Left	53	5	0
Volume Right	5	0	32
cSH	674	1372	1700
Volume to Capacity	0.09	0.00	0.12
Queue Length 95th (ft)	7	0	0
Control Delay (s)	10.8	0.3	0.0
Lane LOS	B	A	
Approach Delay (s)	10.8	0.3	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	20.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
19: 191st Street & Waverly Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	90	40	30	30	40	20	70	50	10	20	100	90
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	95	42	32	32	42	21	74	53	11	21	105	95
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	63			74			511	374	58	400	379	53
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	63			74			511	374	58	400	379	53
tC, single (s)	4.2			4.1			8.1	6.5	6.2	7.1	6.5	6.3
tC, 2 stage (s)												
tF (s)	2.3			2.2			4.4	4.0	3.3	3.5	4.0	3.4
p0 queue free %	94			98			71	90	99	96	79	90
cM capacity (veh/h)	1502			1520			251	514	1014	483	509	995

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	168	95	137	221
Volume Left	95	32	74	21
Volume Right	32	21	11	95
cSH	1502	1520	337	640
Volume to Capacity	0.06	0.02	0.41	0.35
Queue Length 95th (ft)	5	2	48	38
Control Delay (s)	4.5	2.6	22.8	13.6
Lane LOS	A	A	C	B
Approach Delay (s)	4.5	2.6	22.8	13.6
Approach LOS			C	B

Intersection Summary			
Average Delay	11.5		
Intersection Capacity Utilization	44.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
20: W 188th Street & Gardner Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	90	30	250	270	30	290	220	1430	250	240	1100	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	5.0	5.0	5.0	2.5	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.86		1.00	0.98		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1770	1845	1583	1770	1608		1770	3610		1770	3689	1524
Flt Permitted	0.31	1.00	1.00	0.68	1.00		0.16	1.00		0.07	1.00	1.00
Satd. Flow (perm)	569	1845	1583	1273	1608		290	3610		130	3689	1524
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	95	33	263	293	33	315	232	1505	272	261	1158	105
RTOR Reduction (vph)	0	0	218	0	212	0	0	13	0	0	0	47
Lane Group Flow (vph)	95	33	45	293	136	0	232	1764	0	261	1158	58
Heavy Vehicles (%)	2%	3%	2%	2%	3%	2%	2%	3%	2%	2%	3%	6%
Turn Type	pm+pt		Perm	pm+pt			pm+pt			pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	18.4	13.1	13.1	22.9	14.1		69.1	56.0		72.1	57.5	57.5
Effective Green, g (s)	18.4	13.1	13.1	22.9	14.1		69.1	56.0		72.1	57.5	57.5
Actuated g/C Ratio	0.17	0.12	0.12	0.21	0.13		0.63	0.51		0.66	0.52	0.52
Clearance Time (s)	5.0	5.0	5.0	2.5	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	153	220	189	305	206		358	1838		303	1928	797
v/s Ratio Prot	0.03	0.02		c0.08	0.08		0.08	c0.49		c0.11	0.31	
v/s Ratio Perm	0.07		0.03	c0.12			0.33			0.45		0.04
v/c Ratio	0.62	0.15	0.24	0.96	0.66		0.65	0.96		0.86	0.60	0.07
Uniform Delay, d1	40.7	43.5	43.9	42.4	45.7		12.6	25.9		34.5	18.3	13.0
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.26	1.08		1.00	1.00	1.00
Incremental Delay, d2	7.6	0.3	0.7	40.8	7.7		3.2	11.5		21.3	0.5	0.0
Delay (s)	48.3	43.8	44.6	83.2	53.4		19.1	39.6		55.9	18.8	13.1
Level of Service	D	D	D	F	D		B	D		E	B	B
Approach Delay (s)		45.4			67.0			37.2			24.7	
Approach LOS		D			E			D			C	

Intersection Summary			
HCM Average Control Delay	37.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	99.6%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
21: I-35 SB Ramps & Gardner Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	400	0	1150	30	750	0	0	1220	390
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)				5.0	5.0	2.5	2.5	5.0			5.0	
Lane Util. Factor				1.00	0.95	0.95	1.00	0.95			0.95	
Frt				1.00	0.85	0.85	1.00	1.00			0.96	
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1752	1475	1475	1687	3725			3580	
Flt Permitted				0.95	1.00	1.00	0.08	1.00			1.00	
Satd. Flow (perm)				1752	1475	1475	149	3725			3580	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	421	0	1211	32	789	0	0	1284	411
RTOR Reduction (vph)	0	0	0	0	430	16	0	0	0	0	25	0
Lane Group Flow (vph)	0	0	0	421	176	589	32	789	0	0	1670	0
Heavy Vehicles (%)	0%	0%	0%	3%	0%	4%	7%	2%	0%	3%	3%	0%
Turn Type				custom		custom	pm+pt					
Protected Phases				8	8	1	5	2			6	
Permitted Phases				8		8	2					
Actuated Green, G (s)				31.1	31.1	49.1	50.9	48.4			63.1	
Effective Green, g (s)				31.1	31.1	49.1	50.9	48.4			63.1	
Actuated g/C Ratio				0.28	0.28	0.45	0.46	0.44			0.57	
Clearance Time (s)				5.0	5.0	2.5	2.5	5.0			5.0	
Vehicle Extension (s)				3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)				495	417	658	115	1639			2054	
v/s Ratio Prot				0.24	0.12	c0.15	0.01	c0.21			c0.47	
v/s Ratio Perm						0.25	0.12					
v/c Ratio				0.85	0.42	0.90	0.28	0.48			0.81	
Uniform Delay, d1				37.3	32.1	28.1	32.9	21.9			18.7	
Progression Factor				1.00	1.00	1.00	0.57	0.50			0.74	
Incremental Delay, d2				13.2	0.7	14.8	0.9	0.7			2.8	
Delay (s)				50.4	32.8	42.8	19.5	11.5			16.7	
Level of Service				D	C	D	B	B			B	
Approach Delay (s)		0.0			41.1			11.9			16.7	
Approach LOS		A			D			B			B	

Intersection Summary			
HCM Average Control Delay	25.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	5.0
Intersection Capacity Utilization	82.6%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner IMF Operations - (Improved) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

22: I-35 NB Ramps & Gardner Rd

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	180	0	20	0	0	0	0	600	250	760	870	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0						5.0	5.0	5.0	5.0	
Lane Util. Factor		1.00						1.00	1.00	0.97	0.95	
Frt		0.99						1.00	0.85	1.00	1.00	
Flt Protected		0.96						1.00	1.00	0.95	1.00	
Satd. Flow (prot)		1694						1961	1568	3367	3725	
Flt Permitted		0.96						1.00	1.00	0.95	1.00	
Satd. Flow (perm)		1694						1961	1568	3367	3725	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	189	0	21	0	0	0	0	632	263	800	916	0
RTOR Reduction (vph)	0	3	0	0	0	0	0	0	147	0	0	0
Lane Group Flow (vph)	0	207	0	0	0	0	0	632	116	800	916	0
Heavy Vehicles (%)	6%	0%	5%	0%	0%	0%	0%	2%	3%	4%	2%	0%
Turn Type	Split								Perm	Prot		
Protected Phases	4	4						2		1	6	
Permitted Phases									2			
Actuated Green, G (s)		16.8						48.5	48.5	29.7	83.2	
Effective Green, g (s)		16.8						48.5	48.5	29.7	83.2	
Actuated g/C Ratio		0.15						0.44	0.44	0.27	0.76	
Clearance Time (s)		5.0						5.0	5.0	5.0	5.0	
Vehicle Extension (s)		3.0						3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)		259						865	691	909	2817	
v/s Ratio Prot		c0.12						c0.32		c0.24	0.25	
v/s Ratio Perm									0.07			
v/c Ratio		0.80						0.73	0.17	0.88	0.33	
Uniform Delay, d1		45.0						25.4	18.6	38.4	4.3	
Progression Factor		1.00						0.93	1.34	1.02	1.31	
Incremental Delay, d2		15.6						4.8	0.5	6.2	0.2	
Delay (s)		60.5						28.4	25.4	45.5	5.9	
Level of Service		E						C	C	D	A	
Approach Delay (s)		60.5			0.0			27.5			24.4	
Approach LOS		E			A			C			C	

Intersection Summary			
HCM Average Control Delay	28.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	82.6%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

23: E 191st Street & Gardner Rd

PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	30	140	710	20	60	830
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		5.0			5.0
Lane Util. Factor	1.00		1.00			1.00
Frt	0.89		1.00			1.00
Flt Protected	0.99		1.00			1.00
Satd. Flow (prot)	1613		1857			1850
Flt Permitted	0.99		1.00			0.91
Satd. Flow (perm)	1613		1857			1686
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	32	147	747	21	63	874
RTOR Reduction (vph)	135	0	1	0	0	0
Lane Group Flow (vph)	44	0	767	0	0	937
Heavy Vehicles (%)	3%	4%	2%	0%	7%	2%
Turn Type					Perm	
Protected Phases	8		2			6
Permitted Phases					6	
Actuated Green, G (s)	8.9		91.1			91.1
Effective Green, g (s)	8.9		91.1			91.1
Actuated g/C Ratio	0.08		0.83			0.83
Clearance Time (s)	5.0		5.0			5.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	131		1538			1396
v/s Ratio Prot	c0.03		0.41			
v/s Ratio Perm						c0.56
v/c Ratio	0.34		0.50			0.67
Uniform Delay, d1	47.8		2.8			3.7
Progression Factor	1.00		1.00			1.33
Incremental Delay, d2	1.5		0.3			2.5
Delay (s)	49.3		3.0			7.4
Level of Service	D		A			A
Approach Delay (s)	49.3		3.0			7.4
Approach LOS	D		A			A

Intersection Summary			
HCM Average Control Delay	9.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	108.4%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

24: Sunflower Road & US 56

PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	90	10	370	30	10	10	110	290	10	170	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.99			1.00			0.90			1.00	
Flt Protected		1.00			0.96			1.00			1.00	
Satd. Flow (prot)		1857			1764			1631			1805	
Flt Permitted		1.00			0.67			0.99			0.97	
Satd. Flow (perm)		1857			1241			1621			1764	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	95	11	389	32	11	11	116	305	11	179	5
RTOR Reduction (vph)	0	4	0	0	1	0	0	95	0	0	1	0
Lane Group Flow (vph)	0	102	0	0	431	0	0	337	0	0	194	0
Heavy Vehicles (%)	0%	1%	0%	3%	0%	0%	0%	9%	4%	0%	5%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		32.4			32.4			47.6			47.6	
Effective Green, g (s)		32.4			32.4			47.6			47.6	
Actuated g/C Ratio		0.36			0.36			0.53			0.53	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		669			447			857			933	
v/s Ratio Prot		0.05										
v/s Ratio Perm					c0.35			c0.21			0.11	
v/c Ratio		0.15			0.96			0.39			0.21	
Uniform Delay, d1		19.5			28.2			12.6			11.2	
Progression Factor		1.00			0.85			0.86			1.31	
Incremental Delay, d2		0.1			25.2			1.3			0.5	
Delay (s)		19.6			49.3			12.1			15.2	
Level of Service		B			D			B			B	
Approach Delay (s)		19.6			49.3			12.1			15.2	
Approach LOS		B			D			B			B	

Intersection Summary			
HCM Average Control Delay	27.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)

25: US 56 & 4th Street

PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	320	130	90	460	150	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0			5.0	5.0	
Lane Util. Factor	1.00			1.00	1.00	
Frt	0.96			1.00	0.95	
Flt Protected	1.00			0.99	0.97	
Satd. Flow (prot)	1753			1833	1715	
Flt Permitted	1.00			0.86	0.97	
Satd. Flow (perm)	1753			1581	1715	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	337	137	95	484	158	95
RTOR Reduction (vph)	13	0	0	0	27	0
Lane Group Flow (vph)	461	0	0	579	226	0
Heavy Vehicles (%)	5%	2%	2%	3%	2%	2%
Turn Type			Perm			
Protected Phases	4			8	2	
Permitted Phases			8			
Actuated Green, G (s)	63.1			63.1	16.9	
Effective Green, g (s)	63.1			63.1	16.9	
Actuated g/C Ratio	0.70			0.70	0.19	
Clearance Time (s)	5.0			5.0	5.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	1229			1108	322	
v/s Ratio Prot	0.26				c0.13	
v/s Ratio Perm				c0.37		
v/c Ratio	0.38			0.52	0.70	
Uniform Delay, d1	5.5			6.3	34.2	
Progression Factor	1.00			0.52	1.00	
Incremental Delay, d2	0.9			1.2	6.8	
Delay (s)	6.3			4.5	41.0	
Level of Service	A			A	D	
Approach Delay (s)	6.3			4.5	41.0	
Approach LOS	A			A	D	

Intersection Summary			
HCM Average Control Delay	12.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	80.3%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner IMF Operations - (Improved) - PM Peak Hour - Synchro Intersection LOS

26: 199th Street & Four Corners Road

PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	390	420	130	120	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	11	411	442	137	126	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	579				942	511
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	579				942	511
tC, single (s)	4.5				7.4	6.8
tC, 2 stage (s)						
tF (s)	2.6				4.4	3.8
p0 queue free %	99				36	99
cM capacity (veh/h)	832				196	464

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	421	579	132
Volume Left	11	0	126
Volume Right	0	137	5
cSH	832	1700	201
Volume to Capacity	0.01	0.34	0.66
Queue Length 95th (ft)	1	0	98
Control Delay (s)	0.4	0.0	51.7
Lane LOS	A		F
Approach Delay (s)	0.4	0.0	51.7
Approach LOS			F

Intersection Summary			
Average Delay	6.2		
Intersection Capacity Utilization	43.6%	ICU Level of Service	A
Analysis Period (min)	15		

27: 199th Street & Gardner Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	150	20	30	210	330	10	130	30	440	200	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00		1.00		1.00	1.00	1.00
Frt	1.00	0.98		1.00	1.00	0.85		0.98		1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		1.00		0.95	1.00	1.00
Satd. Flow (prot)	1805	1803		1752	1827	1583		1798		1770	1863	1568
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.98		0.53	1.00	1.00
Satd. Flow (perm)	1805	1803		1752	1827	1583		1768		991	1863	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	158	21	32	221	347	11	137	32	463	211	32
RTOR Reduction (vph)	0	6	0	0	0	276	0	8	0	0	0	13
Lane Group Flow (vph)	21	173	0	32	221	71	0	172	0	463	211	19
Heavy Vehicles (%)	0%	4%	0%	3%	4%	2%	0%	3%	3%	2%	2%	3%
Turn Type	Prot			Prot		Perm	Perm			pm+pt		Perm
Protected Phases	5	2		1	6			8		7	4	
Permitted Phases						6	8			4		4
Actuated Green, G (s)	3.1	14.7		6.9	18.5	18.5		31.5		53.4	53.4	53.4
Effective Green, g (s)	3.1	14.7		6.9	18.5	18.5		31.5		53.4	53.4	53.4
Actuated g/C Ratio	0.03	0.16		0.08	0.21	0.21		0.35		0.59	0.59	0.59
Clearance Time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	62	294		134	376	325		619		734	1105	930
v/s Ratio Prot	0.01	c0.10		0.02	c0.12					c0.12	0.11	
v/s Ratio Perm						0.05		0.10		c0.26		0.01
v/c Ratio	0.34	0.59		0.24	0.59	0.22		0.28		0.63	0.19	0.02
Uniform Delay, d1	42.4	34.9		39.1	32.3	29.7		21.1		10.9	8.4	7.5
Progression Factor	0.91	1.02		1.00	1.00	1.00		1.00		1.00	1.00	1.00
Incremental Delay, d2	3.2	3.0		0.9	2.3	0.3		1.1		1.8	0.4	0.0
Delay (s)	41.9	38.6		40.0	34.7	30.1		22.2		12.7	8.8	7.6
Level of Service	D	D		D	C	C		C		B	A	A
Approach Delay (s)		38.9			32.3			22.2			11.3	
Approach LOS		D			C			C			B	

Intersection Summary			
HCM Average Control Delay	23.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	64.6%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

30: US-56 & I-35 NB Loop

PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	1530	1330	0	1910	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	1611	1400	0	2011	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked					0.59	
vC, conflicting volume			3011		2616	805
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			3011		2353	805
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			116		18	330

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	805	805	1400	1005	1005
Volume Left	0	0	0	0	0
Volume Right	0	0	1400	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.47	0.47	0.82	0.59	0.59
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	85.7%	ICU Level of Service	E
Analysis Period (min)	15		

37: 199th Street & West Waverley

PM Peak Hour

Movement	EBL	EBT	WBU	WBT	WBR	SWL	SWR
Lane Configurations							
Volume (veh/h)	5	800	0	840	120	160	5
Sign Control		Free		Free		Stop	
Grade		0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	870	0	913	130	174	5
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type		TWLTL		TWLTL			
Median storage veh)		2		2			
Upstream signal (ft)				802			
pX, platoon unblocked			0.00				
vC, conflicting volume	1043		0			1859	978
vC1, stage 1 conf vol						978	
vC2, stage 2 conf vol						880	
vCu, unblocked vol	1043		0			1859	978
tC, single (s)	4.1		0.0			6.6	6.2
tC, 2 stage (s)						5.6	
tF (s)	2.2		0.0			3.7	3.3
p0 queue free %	99		0			31	98
cM capacity (veh/h)	674		0			252	306

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SW 1
Volume Total	5	870	1043	0	179
Volume Left	5	0	0	0	174
Volume Right	0	0	130	0	5
cSH	674	1700	1700	1700	253
Volume to Capacity	0.01	0.51	0.61	0.00	0.71
Queue Length 95th (ft)	1	0	0	0	120
Control Delay (s)	10.4	0.0	0.0	0.0	47.6
Lane LOS	B				E
Approach Delay (s)	0.1		0.0		47.6
Approach LOS					E

Intersection Summary			
Average Delay	4.1		
Intersection Capacity Utilization	67.3%	ICU Level of Service	C
Analysis Period (min)	15		

2030 Gardner IMF Operations - (Improved) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
38: 199th Street & IH-35 SB Ramp — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	740	220	120	150	0	0	0	0	10	0	810
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		1.00		1.00	1.00					1.00		1.00
Frt		0.97		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		1572		1752	1743					1805		1302
Flt Permitted		1.00		0.07	1.00					0.95		1.00
Satd. Flow (perm)		1572		124	1743					1805		1302
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	804	239	130	163	0	0	0	0	11	0	880
RTOR Reduction (vph)	0	11	0	0	0	0	0	0	0	0	0	611
Lane Group Flow (vph)	0	1032	0	130	163	0	0	0	0	11	0	269
Heavy Vehicles (%)	0%	21%	4%	3%	9%	0%	0%	0%	0%	0%	0%	24%
Turn Type				pm+pt						Prot		custom
Protected Phases		4		3	8					6		
Permitted Phases				8								3 6
Actuated Green, G (s)		54.7		75.0	75.0					5.0		25.3
Effective Green, g (s)		54.7		75.0	75.0					5.0		25.3
Actuated g/C Ratio		0.61		0.83	0.83					0.06		0.28
Clearance Time (s)		5.0		5.0	5.0					5.0		
Vehicle Extension (s)		3.0		3.0	3.0					3.0		
Lane Grp Cap (vph)		955		380	1453					100		366
v/s Ratio Prot		c0.66		0.06	0.09					0.01		
v/s Ratio Perm				0.23								c0.21
v/c Ratio		1.08		0.34	0.11					0.11		0.73
Uniform Delay, d1		17.6		18.2	1.4					40.4		29.3
Progression Factor		0.93		0.75	0.88					1.00		1.00
Incremental Delay, d2		53.5		0.5	0.0					0.5		7.5
Delay (s)		69.9		14.2	1.2					40.9		36.8
Level of Service		E		B	A					D		D
Approach Delay (s)		69.9			7.0			0.0			36.8	
Approach LOS		E			A			A			D	

Intersection Summary			
HCM Average Control Delay	48.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	74.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
39: 199th Street & IH-35 NB Ramp — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	650	90	0	0	200	20	70	0	50	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0		5.0			
Lane Util. Factor	1.00	1.00			1.00		1.00		1.00			
Frt	1.00	1.00			0.99		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1456	1792			1795		1641		1583			
Flt Permitted	0.45	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	691	1792			1795		1641		1583			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	707	98	0	0	217	22	76	0	54	0	0	0
RTOR Reduction (vph)	0	0	0	0	3	0	0	0	49	0	0	0
Lane Group Flow (vph)	707	98	0	0	236	0	76	0	5	0	0	0
Heavy Vehicles (%)	24%	6%	0%	0%	5%	0%	10%	0%	2%	0%	0%	0%
Turn Type	pm+pt						custom		custom			
Protected Phases	7	4			8							
Permitted Phases	4						2		2			
Actuated Green, G (s)	71.6	71.6			30.1		8.4		8.4			
Effective Green, g (s)	71.6	71.6			30.1		8.4		8.4			
Actuated g/C Ratio	0.80	0.80			0.33		0.09		0.09			
Clearance Time (s)	5.0	5.0			5.0		5.0		5.0			
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Lane Grp Cap (vph)	860	1426			600		153		148			
v/s Ratio Prot	c0.33	0.05			0.13							
v/s Ratio Perm	c0.32						c0.05		0.00			
v/c Ratio	0.82	0.07			0.39		0.50		0.03			
Uniform Delay, d1	5.9	2.0			22.9		38.8		37.1			
Progression Factor	0.71	0.03			0.45		1.00		1.00			
Incremental Delay, d2	0.6	0.0			0.4		2.5		0.1			
Delay (s)	4.8	0.1			10.8		41.3		37.2			
Level of Service	A	A			B		D		D			
Approach Delay (s)		4.2			10.8			39.6			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	9.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	74.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
40: 199th Street & East Waverley — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	140	10	5	220	10	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	152	11	5	239	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	820					
pX, platoon unblocked						
vC, conflicting volume			163		408	158
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			163		408	158
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	99
cM capacity (veh/h)			1428		601	893

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	163	245	16
Volume Left	0	5	11
Volume Right	11	0	5
cSH	1700	1428	675
Volume to Capacity	0.10	0.00	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.2	10.5
Lane LOS		A	B
Approach Delay (s)	0.0	0.2	10.5
Approach LOS			B

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	25.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
80: 191st Street & Driveway A — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	130	10	10	80	40	120
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	141	11	11	87	43	130
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	98				348	54
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	98				348	54
tC, single (s)	5.1				7.4	7.2
tC, 2 stage (s)						
tF (s)	3.1				4.4	4.2
p0 queue free %	87				90	84
cM capacity (veh/h)	1054				425	793

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	152	98	43	130
Volume Left	141	0	43	0
Volume Right	0	87	0	130
cSH	1054	1700	425	793
Volume to Capacity	0.13	0.06	0.10	0.16
Queue Length 95th (ft)	12	0	8	15
Control Delay (s)	8.4	0.0	14.4	10.4
Lane LOS	A		B	B
Approach Delay (s)	8.4	0.0	11.4	
Approach LOS			B	

Intersection Summary			
Average Delay	7.7		
Intersection Capacity Utilization	24.4%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner IMF Operations - (Improved) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
82: Driveway C & Waverly Road — PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	10	10	5	150	190	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	11	5	163	207	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	383	209	212			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	383	209	212			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	99	100			
cM capacity (veh/h)	621	836	1370			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	11	11	168	212
Volume Left	11	0	5	0
Volume Right	0	11	0	5
cSH	621	836	1370	1700
Volume to Capacity	0.02	0.01	0.00	0.12
Queue Length 95th (ft)	1	1	0	0
Control Delay (s)	10.9	9.4	0.3	0.0
Lane LOS	B	A	A	
Approach Delay (s)	10.1		0.3	0.0
Approach LOS	B			

Intersection Summary			
Average Delay	0.7		
Intersection Capacity Utilization	21.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved)
84: 191st Street & Driveway E — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	50	90	0	5	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	54	98	0	5	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	98				152	98
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	98				152	98
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	99
cM capacity (veh/h)	1508				844	964

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	54	98	11
Volume Left	0	0	5
Volume Right	0	0	5
cSH	1508	1700	900
Volume to Capacity	0.00	0.06	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	0.0	9.0
Lane LOS			A
Approach Delay (s)	0.0	0.0	9.0
Approach LOS			A

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	14.7%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner IMF Operations - (Improved + Mitigated) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

1: 175th Street & Waverly Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	10	390	10	20	30	700	270	10	10	180	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.91		1.00	0.99		1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1659		1805	1819		1770	3522		1805	3437	
Flt Permitted	0.72	1.00		0.38	1.00		0.61	1.00		0.57	1.00	
Satd. Flow (perm)	1346	1659		724	1819		1132	3522		1086	3437	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	53	11	411	11	21	32	737	284	11	11	189	42
RTOR Reduction (vph)	0	363	0	0	28	0	0	2	0	0	14	0
Lane Group Flow (vph)	53	59	0	11	25	0	737	293	0	11	217	0
Heavy Vehicles (%)	2%	0%	3%	0%	0%	0%	2%	2%	0%	0%	2%	3%
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	10.5	10.5		10.5	10.5		69.5	61.2		46.4	43.1	
Effective Green, g (s)	10.5	10.5		10.5	10.5		69.5	61.2		46.4	43.1	
Actuated g/C Ratio	0.12	0.12		0.12	0.12		0.77	0.68		0.52	0.48	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	157	194		84	212		1026	2395		586	1646	
v/s Ratio Prot		0.04			0.01		c0.17	0.08		0.00	0.06	
v/s Ratio Perm	c0.04			0.02			c0.38			0.01		
v/c Ratio	0.34	0.30		0.13	0.12		0.72	0.12		0.02	0.13	
Uniform Delay, d1	36.6	36.4		35.7	35.6		6.7	5.0		10.6	13.0	
Progression Factor	1.00	1.00		1.00	1.00		0.53	0.87		1.00	1.00	
Incremental Delay, d2	1.3	0.9		0.7	0.2		2.0	0.1		0.0	0.2	
Delay (s)	37.8	37.3		36.4	35.8		5.6	4.4		10.6	13.2	
Level of Service	D	D		D	D		A	A		B	B	
Approach Delay (s)		37.4			35.9			5.3			13.1	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM Average Control Delay	15.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	81.0%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

2: US 56 & Gardner Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	140	450	60	310	900	390	50	870	220	320	890	130
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3519	1583	1770	3689	1583	1770	3689	1568	3400	3438	
Flt Permitted	0.16	1.00	1.00	0.38	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	297	3519	1583	702	3689	1583	1770	3689	1568	3400	3438	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	147	474	63	326	947	411	53	916	232	337	937	137
RTOR Reduction (vph)	0	0	45	0	0	230	0	0	157	0	12	0
Lane Group Flow (vph)	147	474	18	326	947	181	53	916	75	337	1062	0
Heavy Vehicles (%)	2%	8%	2%	2%	3%	2%	2%	3%	3%	3%	3%	3%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			
Actuated Green, G (s)	31.8	25.1	25.1	34.0	26.2	26.2	3.9	29.1	29.1	11.3	36.5	
Effective Green, g (s)	31.8	25.1	25.1	34.0	26.2	26.2	3.9	29.1	29.1	11.3	36.5	
Actuated g/C Ratio	0.35	0.28	0.28	0.38	0.29	0.29	0.04	0.32	0.32	0.13	0.41	
Clearance Time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	215	981	441	358	1074	461	77	1193	507	427	1394	
v/s Ratio Prot	0.05	0.13		c0.08	0.26		c0.03	c0.25		c0.10	0.31	
v/s Ratio Perm	0.19		0.01	c0.27		0.11			0.05			
v/c Ratio	0.68	0.48	0.04	0.91	0.88	0.39	0.69	0.77	0.15	0.79	0.76	
Uniform Delay, d1	22.5	27.0	23.7	24.6	30.4	25.5	42.5	27.4	21.6	38.2	23.0	
Progression Factor	1.35	0.67	0.40	1.32	1.15	2.01	0.73	0.56	0.30	1.00	1.00	
Incremental Delay, d2	8.6	1.7	0.2	20.7	7.8	1.8	14.1	1.8	0.1	9.4	2.5	
Delay (s)	38.9	19.8	9.6	53.1	42.7	53.1	45.2	17.1	6.7	47.6	25.5	
Level of Service	D	B	A	D	D	D	D	B	A	D	C	
Approach Delay (s)		23.0			47.3			16.3			30.8	
Approach LOS		C			D			B			C	

Intersection Summary			
HCM Average Control Delay	31.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.8
Intersection Capacity Utilization	79.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

3: US 56 & Elm

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	980	30	40	1610	40	20	10	50	100	20	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			1.00		1.00	0.88		1.00	0.91	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3425			3521		1719	1637		1770	1697	
Flt Permitted		0.93			0.90		0.72	1.00		0.72	1.00	
Satd. Flow (perm)		3176			3157		1307	1637		1332	1697	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	11	1032	32	42	1695	42	21	11	53	105	21	32
RTOR Reduction (vph)	0	2	0	0	1	0	0	47	0	0	25	0
Lane Group Flow (vph)	0	1073	0	0	1778	0	21	17	0	105	28	0
Heavy Vehicles (%)	0%	5%	3%	3%	2%	3%	5%	0%	2%	2%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		70.0			70.0		11.0	11.0		11.0	11.0	
Effective Green, g (s)		70.0			70.0		11.0	11.0		11.0	11.0	
Actuated g/C Ratio		0.78			0.78		0.12	0.12		0.12	0.12	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2470			2455		160	200		163	207	
v/s Ratio Prot								0.01			0.02	
v/s Ratio Perm		0.34			c0.56		0.02			c0.08		
v/c Ratio		0.43			0.72		0.13	0.09		0.64	0.13	
Uniform Delay, d1		3.4			5.1		35.2	35.0		37.6	35.2	
Progression Factor		0.42			1.24		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.5			1.4		0.4	0.2		8.4	0.3	
Delay (s)		1.9			7.7		35.6	35.2		46.1	35.5	
Level of Service		A			A		D	D		D	D	
Approach Delay (s)		1.9			7.7			35.3			42.5	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	8.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	94.2%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

4: US 56 & Mulberry

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	1110	10	30	1720	40	10	5	20	40	10	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			1.00		1.00	0.88		1.00	0.90	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3435			3523		1805	1605		1752	1713	
Flt Permitted		0.89			0.91		0.74	1.00		0.74	1.00	
Satd. Flow (perm)		3045			3211		1399	1605		1366	1713	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	1168	11	32	1811	42	11	5	21	42	11	21
RTOR Reduction (vph)	0	1	0	0	1	0	0	19	0	0	19	0
Lane Group Flow (vph)	0	1199	0	0	1884	0	11	7	0	42	13	0
Heavy Vehicles (%)	0%	5%	0%	3%	2%	3%	0%	0%	5%	3%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		73.8			73.8		7.2	7.2		7.2	7.2	
Effective Green, g (s)		73.8			73.8		7.2	7.2		7.2	7.2	
Actuated g/C Ratio		0.82			0.82		0.08	0.08		0.08	0.08	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2497			2633		112	128		109	137	
v/s Ratio Prot								0.00			0.01	
v/s Ratio Perm		0.39			c0.59		0.01			c0.03		
v/c Ratio		0.48			0.72		0.10	0.05		0.39	0.09	
Uniform Delay, d1		2.4			3.5		38.4	38.2		39.3	38.4	
Progression Factor		0.39			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.6			0.9		0.4	0.2		2.3	0.3	
Delay (s)		1.6			4.5		38.8	38.4		41.6	38.7	
Level of Service		A			A		D	D		D	D	
Approach Delay (s)		1.6			4.5			38.5			40.3	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	4.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	86.6%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

5: US 56 & Moonlight Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	150	770	250	380	1500	1300	200	550	160	730	720	160
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1736	3585	1583	1770	3725	1583	1770	3725	1583	3433	3539	1553
Flt Permitted	0.09	1.00	1.00	0.18	1.00	1.00	0.28	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	172	3585	1583	333	3725	1583	514	3725	1583	3433	3539	1553
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	158	811	263	400	1579	1368	211	579	168	768	758	168
RTOR Reduction (vph)	0	0	124	0	0	227	0	0	116	0	0	93
Lane Group Flow (vph)	158	811	139	400	1579	1141	211	579	52	768	758	75
Heavy Vehicles (%)	4%	6%	2%	2%	2%	2%	2%	2%	2%	2%	2%	4%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		custom	Prot		Perm
Protected Phases	5	2		1	6		3	8	8	7	4	
Permitted Phases	2		2	6		6	8		8			4
Actuated Green, G (s)	48.4	42.4	42.4	69.5	58.0	58.0	23.0	14.5	14.5	18.5	24.5	24.5
Effective Green, g (s)	48.4	42.4	42.4	69.5	58.0	58.0	23.0	14.5	14.5	18.5	24.5	24.5
Actuated g/C Ratio	0.40	0.35	0.35	0.58	0.48	0.48	0.19	0.12	0.12	0.15	0.20	0.20
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	148	1267	559	452	1800	765	187	450	191	529	723	317
v/s Ratio Prot	0.05	0.23		c0.16	0.42		0.08	c0.16	0.03	c0.22	0.21	
v/s Ratio Perm	0.38		0.09	0.35		c0.72	0.14					0.05
v/c Ratio	1.07	0.64	0.25	0.88	0.88	1.49	1.13	1.29	0.27	1.45	1.05	0.24
Uniform Delay, d1	31.1	32.4	27.5	23.6	27.8	31.0	46.8	52.8	48.0	50.7	47.8	39.9
Progression Factor	1.00	1.00	1.00	0.91	0.97	0.98	0.90	0.89	0.78	1.00	1.00	1.00
Incremental Delay, d2	93.1	2.5	1.1	5.2	1.7	223.0	101.1	143.5	0.3	213.7	46.9	0.1
Delay (s)	124.2	34.9	28.6	26.7	28.6	253.5	143.1	190.7	37.7	264.5	94.6	40.1
Level of Service	F	C	C	C	C	F	F	F	D	F	F	D
Approach Delay (s)		45.0			120.3			153.4			166.2	
Approach LOS		D			F			F			F	

Intersection Summary			
HCM Average Control Delay	122.6	HCM Level of Service	F
HCM Volume to Capacity ratio	1.44		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	117.8%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

6: Old US 56 & US 56 — PM Peak Hour

Movement	NBL	NBR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	700	130	1360	300	10	2480
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	0.97	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	3400	1599	3654	1553	1805	3725
Flt Permitted	0.95	1.00	1.00	1.00	0.12	1.00
Satd. Flow (perm)	3400	1599	3654	1553	230	3725
Peak-hour factor, PHF	0.97	0.97	0.95	0.95	0.95	0.95
Adj. Flow (vph)	722	134	1432	316	11	2611
RTOR Reduction (vph)	0	83	0	42	0	0
Lane Group Flow (vph)	722	51	1432	274	11	2611
Heavy Vehicles (%)	3%	1%	4%	4%	0%	2%
Turn Type		Perm		pm+ov	pm+pt	
Protected Phases	8		2	8	1	6
Permitted Phases		8	2	2	6	6
Actuated Green, G (s)	25.0	25.0	79.2	104.2	85.0	85.0
Effective Green, g (s)	25.0	25.0	79.2	104.2	85.0	85.0
Actuated g/C Ratio	0.21	0.21	0.66	0.87	0.71	0.71
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	708	333	2412	1413	173	2639
v/s Ratio Prot	c0.21		0.39	0.04	0.00	c0.70
v/s Ratio Perm		0.03		0.14	0.04	
v/c Ratio	1.02	0.15	0.59	0.19	0.06	0.99
Uniform Delay, d1	47.5	38.8	11.4	1.3	8.9	17.1
Progression Factor	1.00	1.00	0.19	0.65	0.99	0.52
Incremental Delay, d2	38.9	0.2	0.3	0.0	0.1	11.2
Delay (s)	86.4	39.1	2.4	0.8	8.8	20.0
Level of Service	F	D	A	A	A	C
Approach Delay (s)	79.0		2.1			20.0
Approach LOS	E		A			B

Intersection Summary			
HCM Average Control Delay	23.7	HCM Level of Service	C
HCM Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	93.4%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

7: US-56 & Cedar Niles — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	60	2100	190	800	2020	60	210	20	850	60	20	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2	5.2	5.2	5.2	5.2
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00	1.00	1.00	0.88	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3689	1583	3433	3689	1583	1770	2000	2787	1770	2000	1568
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.74	1.00	1.00	0.74	1.00	1.00
Satd. Flow (perm)	1770	3689	1583	3433	3689	1583	1385	2000	2787	1385	2000	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	63	2211	200	842	2126	63	221	21	895	63	21	42
RTOR Reduction (vph)	0	0	77	0	0	18	0	0	0	0	0	38
Lane Group Flow (vph)	63	2211	123	842	2126	45	221	21	895	63	21	4
Heavy Vehicles (%)	2%	3%	2%	2%	3%	2%	2%	0%	2%	2%	0%	3%
Turn Type	Prot		Perm	Prot		Perm	Perm		pt+ov	Perm		Perm
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases			2			6	8			4		4
Actuated Green, G (s)	5.6	68.8	68.8	23.0	86.2	86.2	12.6	12.6	40.8	12.6	12.6	12.6
Effective Green, g (s)	5.6	68.8	68.8	23.0	86.2	86.2	12.6	12.6	40.8	12.6	12.6	12.6
Actuated g/C Ratio	0.05	0.57	0.57	0.19	0.72	0.72	0.10	0.10	0.34	0.10	0.10	0.10
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2		5.2	5.2	5.2
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lane Grp Cap (vph)	83	2115	908	658	2650	1137	145	210	948	145	210	165
v/s Ratio Prot	0.04	c0.60		c0.25	0.58			0.01	0.32		0.01	
v/s Ratio Perm			0.08			0.03	c0.16			0.05		0.00
v/c Ratio	0.76	1.05	0.14	1.28	0.80	0.04	1.52	0.10	0.94	0.43	0.10	0.03
Uniform Delay, d1	56.5	25.6	11.8	48.5	11.2	4.9	53.7	48.6	38.5	50.4	48.6	48.2
Progression Factor	0.82	0.57	0.07	1.08	1.00	1.05	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	28.0	32.3	0.3	127.0	0.2	0.0	267.7	0.1	17.0	0.8	0.1	0.0
Delay (s)	74.4	46.9	1.1	179.4	11.5	5.1	321.4	48.6	55.5	51.1	48.6	48.2
Level of Service	E	D	A	F	B	A	F	D	E	D	D	D
Approach Delay (s)		43.9			58.0			107.1			49.7	
Approach LOS		D			E			F			D	

Intersection Summary			
HCM Average Control Delay	60.9	HCM Level of Service	E
HCM Volume to Capacity ratio	1.15		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.6
Intersection Capacity Utilization	109.3%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

8: US-56 & I-35 SB Ramps — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	2700	280	650	1260	0	0	0	0	150	0	1580
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		0.99		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3486		1736	3725					1770		2787
Flt Permitted		1.00		0.24	1.00					0.95		1.00
Satd. Flow (perm)		3486		430	3725					1770		2787
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2842	295	684	1326	0	0	0	0	158	0	1663
RTOR Reduction (vph)	0	7	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	3131	0	684	1326	0	0	0	0	158	0	1663
Heavy Vehicles (%)	0%	2%	3%	4%	2%	0%	0%	0%	0%	2%	0%	2%
Turn Type				pm+pt						custom		custom
Protected Phases		2		1	6					4		5
Permitted Phases				6						4		4
Actuated Green, G (s)		68.0		44.0	44.0					10.0		61.0
Effective Green, g (s)		68.0		44.0	44.0					10.0		61.0
Actuated g/C Ratio		0.57		0.37	0.37					0.08		0.51
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		1975		452	1366					148		1533
v/s Ratio Prot		c0.90		c0.34	0.36					0.09		c0.46
v/s Ratio Perm				0.21								0.14
v/c Ratio		1.59		1.51	0.97					1.07		1.08
Uniform Delay, d1		26.0		34.2	37.4					55.0		29.5
Progression Factor		0.75		0.92	0.88					1.00		1.00
Incremental Delay, d2		263.5		238.7	13.8					93.1		49.7
Delay (s)		283.1		270.2	46.5					148.1		79.2
Level of Service		F		F	D					F		E
Approach Delay (s)		283.1			122.6			0.0			85.2	
Approach LOS		F			F			A			F	

Intersection Summary			
HCM Average Control Delay	185.1	HCM Level of Service	F
HCM Volume to Capacity ratio	1.48		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	139.5%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner IMF Operations - (Improved + Mitigated) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

9: US-56 & I-35 NB Ramps — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1530	0	0	1820	570	100	0	390	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95	0.95			
Frt		1.00			1.00	0.85	1.00	0.85	0.85			
Flt Protected		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (prot)		3725			3539	1538	1703	1408	1408			
Flt Permitted		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (perm)		3725			3539	1538	1703	1408	1408			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1611	0	0	1916	600	105	0	411	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	80	0	0	0	0	0	0
Lane Group Flow (vph)	0	1611	0	0	1916	520	105	206	205	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	5%	6%	0%	9%	0%	0%	0%
Turn Type						Perm	Perm		Perm			
Protected Phases		2			6			8				
Permitted Phases						6	8		8			
Actuated Green, G (s)		86.6			86.6	86.6	23.4	23.4	23.4			
Effective Green, g (s)		86.6			86.6	86.6	23.4	23.4	23.4			
Actuated g/C Ratio		0.72			0.72	0.72	0.19	0.19	0.19			
Clearance Time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0	3.0			
Lane Grp Cap (vph)		2688			2554	1110	332	275	275			
v/s Ratio Prot		0.43			c0.54			c0.15				
v/s Ratio Perm						0.34	0.06		0.15			
v/c Ratio		0.60			0.75	0.47	0.32	0.75	0.75			
Uniform Delay, d1		8.2			10.1	7.0	41.4	45.5	45.5			
Progression Factor		0.38			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2		0.1			1.3	0.3	0.6	10.6	10.5			
Delay (s)		3.2			11.4	7.3	42.0	56.2	56.0			
Level of Service		A			B	A	D	E	E			
Approach Delay (s)		3.2			10.4			53.2			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	12.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	85.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

10: Santa Fe & Moonlight Road — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	250	480	440	160	380	930
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.96		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3398		1770	3539
Flt Permitted	0.95	1.00	1.00		0.37	1.00
Satd. Flow (perm)	1770	1583	3398		698	3539
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	263	505	463	168	400	979
RTOR Reduction (vph)	0	405	18	0	0	0
Lane Group Flow (vph)	263	100	613	0	400	979
Turn Type		Perm			pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8			6	
Actuated Green, G (s)	23.8	23.8	68.4		86.2	86.2
Effective Green, g (s)	23.8	23.8	68.4		86.2	86.2
Actuated g/C Ratio	0.20	0.20	0.57		0.72	0.72
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	351	314	1937		616	2542
v/s Ratio Prot	c0.15		0.18		c0.07	0.28
v/s Ratio Perm		0.06			c0.40	
v/c Ratio	0.75	0.32	0.32		0.65	0.39
Uniform Delay, d1	45.3	41.2	13.5		14.2	6.6
Progression Factor	1.00	1.00	1.00		1.30	1.68
Incremental Delay, d2	8.5	0.6	0.4		1.2	0.2
Delay (s)	53.8	41.8	14.0		19.6	11.3
Level of Service	D	D	B		B	B
Approach Delay (s)	45.9		14.0			13.7
Approach LOS	D		B			B

Intersection Summary			
HCM Average Control Delay	22.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

11: Waverly Road & US 56 — PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	20	310	80	300	240	30	40	100	20	100	160	620
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95		1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.98		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1805	3539	1524	3400	3461		1752	3195	1615	1687	3406	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1805	3539	1524	3400	3461		1752	3195	1615	1687	3406	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	326	84	316	253	32	42	105	21	105	168	653
RTOR Reduction (vph)	0	0	72	0	12	0	0	0	15	0	0	401
Lane Group Flow (vph)	21	326	12	316	273	0	42	105	6	105	168	252
Heavy Vehicles (%)	0%	2%	6%	3%	2%	7%	3%	13%	0%	7%	6%	2%
Turn Type	Prot		Perm	Prot			Prot		Perm	Prot		Perm
Protected Phases	3	8		7	4		5	2		1	6	
Permitted Phases			8					2	2			6
Actuated Green, G (s)	2.2	13.3	13.3	16.6	27.7		5.3	26.2	26.2	13.9	34.8	34.8
Effective Green, g (s)	2.2	13.3	13.3	16.6	27.7		5.3	26.2	26.2	13.9	34.8	34.8
Actuated g/C Ratio	0.02	0.15	0.15	0.18	0.31		0.06	0.29	0.29	0.15	0.39	0.39
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	44	523	225	627	1065		103	930	470	261	1317	612
v/s Ratio Prot	0.01	c0.09		c0.09	0.08		0.02	0.03		c0.06	0.05	
v/s Ratio Perm			0.01						0.00			c0.16
v/c Ratio	0.48	0.62	0.06	0.50	0.26		0.41	0.11	0.01	0.40	0.13	0.41
Uniform Delay, d1	43.3	36.0	33.0	33.0	23.4		40.8	23.4	22.7	34.3	17.8	20.1
Progression Factor	1.00	1.00	1.00	0.87	0.84		0.88	0.97	1.02	1.51	0.33	2.65
Incremental Delay, d2	7.9	2.3	0.1	0.6	0.1		2.6	0.2	0.0	0.6	0.1	1.1
Delay (s)	51.3	38.3	33.1	29.4	19.8		38.5	22.8	23.2	52.4	6.0	54.6
Level of Service	D	D	C	C	B		D	C	C	D	A	D
Approach Delay (s)		37.9			24.9			26.8			45.5	
Approach LOS		D			C			C			D	

Intersection Summary			
HCM Average Control Delay	36.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	62.8%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

12: 183rd Street & Four Corners Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	50	5	0	30	5	5	50	0	5	20	5
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	53	5	0	32	5	5	53	0	5	21	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	63	37	58	32
Volume Left (vph)	5	0	5	5
Volume Right (vph)	5	5	0	5
Hadj (s)	0.00	-0.04	0.05	-0.01
Departure Headway (s)	4.1	4.1	4.2	4.2
Degree Utilization, x	0.07	0.04	0.07	0.04
Capacity (veh/h)	848	849	827	838
Control Delay (s)	7.5	7.3	7.5	7.3
Approach Delay (s)	7.5	7.3	7.5	7.3
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.4		
HCM Level of Service	A		
Intersection Capacity Utilization	17.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2030 Gardner Proposed Action - (Improved+Mitigated)
13: 183rd Street & US 56 | PM Peak Hour

Intersection Sign configuration not allowed in HCM analysis.

BNSF NEPA Traffic Study | 2030 Gardner Proposed Action - (Improved+Mitigated)
14: 183rd Street & Waverly Road | PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	5	260	150	10	160	190
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	274	158	11	168	200
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	700	163			168	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	700	163			168	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	69			88	
cM capacity (veh/h)	360	887			1421	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	279	168	368
Volume Left	5	0	168
Volume Right	274	11	0
cSH	863	1700	1421
Volume to Capacity	0.32	0.10	0.12
Queue Length 95th (ft)	35	0	10
Control Delay (s)	11.2	0.0	4.2
Lane LOS	B		A
Approach Delay (s)	11.2	0.0	4.2
Approach LOS	B		

Intersection Summary			
Average Delay	5.7		
Intersection Capacity Utilization	53.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2030 Gardner Proposed Action - (Improved+Mitigated)
15: 183rd Street & Gardner Road | PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	130	120	160	170	140	90	200	960	280	130	930	120
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.91		1.00	0.94		1.00	0.97		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1713		1770	1764		1787	3394		1770	3449	
Flt Permitted	0.51	1.00		0.21	1.00		0.19	1.00		0.11	1.00	
Satd. Flow (perm)	956	1713		396	1764		364	3394		211	3449	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	126	168	179	147	95	211	1011	295	137	979	126
RTOR Reduction (vph)	0	54	0	0	0	0	0	30	0	0	11	0
Lane Group Flow (vph)	137	240	0	179	242	0	211	1276	0	137	1094	0
Heavy Vehicles (%)	2%	2%	1%	2%	1%	2%	1%	3%	2%	2%	3%	2%
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	21.1	15.1		28.5	18.8		40.3	40.3		40.2	40.2	
Effective Green, g (s)	21.1	15.1		28.5	18.8		40.3	40.3		40.2	40.2	
Actuated g/C Ratio	0.23	0.17		0.32	0.21		0.45	0.45		0.45	0.45	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	278	287		273	368		242	1520		179	1541	
v/s Ratio Prot	0.03	c0.14		c0.07	0.14		0.05	c0.38		0.04	c0.32	
v/s Ratio Perm	0.08			0.14			c0.34			0.30		
v/c Ratio	0.49	0.84		0.66	0.66		0.87	0.84		0.77	0.71	
Uniform Delay, d1	28.6	36.3		24.5	32.6		28.2	22.0		20.7	20.2	
Progression Factor	1.20	1.13		1.00	1.00		1.00	1.00		0.83	0.87	
Incremental Delay, d2	1.4	18.6		5.6	4.2		27.2	5.7		11.7	1.8	
Delay (s)	35.9	59.5		30.1	36.9		55.5	27.7		29.0	19.4	
Level of Service	D	E		C	D		E	C		C	B	
Approach Delay (s)		52.0			34.0			31.6			20.5	
Approach LOS		D			C			C			C	

Intersection Summary			
HCM Average Control Delay	30.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	25.0
Intersection Capacity Utilization	84.9%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study | 2030 Gardner Proposed Action - (Improved+Mitigated)
16: Four Corners Road & US 56 | PM Peak Hour

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	0	20	50	130	170	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	0	21	53	137	179	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	421	179	179			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	421	179	179			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	98	96			
cM capacity (veh/h)	571	869	1397			

Direction, Lane #	SB 1	NE 1	SW 1
Volume Total	21	189	179
Volume Left	0	53	0
Volume Right	21	0	0
cSH	869	1397	1700
Volume to Capacity	0.02	0.04	0.11
Queue Length 95th (ft)	2	3	0
Control Delay (s)	9.2	2.4	0.0
Lane LOS	A	A	
Approach Delay (s)	9.2	2.4	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	31.9%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner IMF Operations - (Improved + Mitigated) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)
17: 191st Street & US 56
PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	50	5	5	120	170	30
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	53	5	5	126	179	32
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	332	195	211			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	332	195	211			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	92	99	100			
cM capacity (veh/h)	661	852	1372			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	58	132	211
Volume Left	53	5	0
Volume Right	5	0	32
cSH	674	1372	1700
Volume to Capacity	0.09	0.00	0.12
Queue Length 95th (ft)	7	0	0
Control Delay (s)	10.8	0.3	0.0
Lane LOS	B	A	
Approach Delay (s)	10.8	0.3	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	20.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)
19: 191st Street & Waverly Road
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	90	40	30	30	40	20	70	50	10	20	100	90
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	95	42	32	32	42	21	74	53	11	21	105	95
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	63			74			511	374	58	400	379	53
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	63			74			511	374	58	400	379	53
tC, single (s)	4.2			4.1			8.1	6.5	6.2	7.1	6.5	6.3
tC, 2 stage (s)												
tF (s)	2.3			2.2			4.4	4.0	3.3	3.5	4.0	3.4
p0 queue free %	94			98			71	90	99	96	79	90
cM capacity (veh/h)	1502			1520			251	514	1014	483	509	995

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	168	95	137	221
Volume Left	95	32	74	21
Volume Right	32	21	11	95
cSH	1502	1520	337	640
Volume to Capacity	0.06	0.02	0.41	0.35
Queue Length 95th (ft)	5	2	48	38
Control Delay (s)	4.5	2.6	22.8	13.6
Lane LOS	A	A	C	B
Approach Delay (s)	4.5	2.6	22.8	13.6
Approach LOS			C	B

Intersection Summary			
Average Delay	11.5		
Intersection Capacity Utilization	44.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)
20: W 188th Street & Gardner Rd
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	90	30	250	270	30	290	220	1430	250	240	1100	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	5.0	5.0	5.0	2.5	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.86		1.00	0.98		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1770	1845	1583	1770	1608		1770	3610		1770	3689	1524
Flt Permitted	0.31	1.00	1.00	0.68	1.00		0.16	1.00		0.07	1.00	1.00
Satd. Flow (perm)	569	1845	1583	1273	1608		290	3610		130	3689	1524
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	95	33	263	293	33	315	232	1505	272	261	1158	105
RTOR Reduction (vph)	0	0	218	0	212	0	0	13	0	0	0	47
Lane Group Flow (vph)	95	33	45	293	136	0	232	1764	0	261	1158	58
Heavy Vehicles (%)	2%	3%	2%	2%	3%	2%	2%	3%	2%	2%	3%	6%
Turn Type	pm+pt		Perm	pm+pt			pm+pt			pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	18.4	13.1	13.1	22.9	14.1		69.1	56.0		72.1	57.5	57.5
Effective Green, g (s)	18.4	13.1	13.1	22.9	14.1		69.1	56.0		72.1	57.5	57.5
Actuated g/C Ratio	0.17	0.12	0.12	0.21	0.13		0.63	0.51		0.66	0.52	0.52
Clearance Time (s)	5.0	5.0	5.0	2.5	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	153	220	189	305	206		358	1838		303	1928	797
v/s Ratio Prot	0.03	0.02		c0.08	0.08		0.08	c0.49		c0.11	0.31	
v/s Ratio Perm	0.07		0.03	c0.12			0.33			0.45		0.04
v/c Ratio	0.62	0.15	0.24	0.96	0.66		0.65	0.96		0.86	0.60	0.07
Uniform Delay, d1	40.7	43.5	43.9	42.4	45.7		12.6	25.9		34.5	18.3	13.0
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.44	0.76		1.00	1.00	1.00
Incremental Delay, d2	7.6	0.3	0.7	40.8	7.7		2.9	10.6		21.3	0.5	0.0
Delay (s)	48.3	43.8	44.6	83.2	53.4		21.0	30.3		55.9	18.8	13.1
Level of Service	D	D	D	F	D		C	C		E	B	B
Approach Delay (s)		45.4			67.0			29.2			24.7	
Approach LOS		D			E			C			C	

Intersection Summary			
HCM Average Control Delay	34.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	99.6%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)
21: I-35 SB Ramps & Gardner Rd
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	400	0	1150	30	750	0	0	1220	390
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)				5.0	5.0	2.5	2.5	5.0			5.0	
Lane Util. Factor				1.00	0.95	0.95	1.00	0.95			0.95	
Frt				1.00	0.85	0.85	1.00	1.00			0.96	
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1752	1475	1475	1687	3725			3580	
Flt Permitted				0.95	1.00	1.00	0.11	1.00			1.00	
Satd. Flow (perm)				1752	1475	1475	201	3725			3580	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	421	0	1211	32	789	0	0	1284	411
RTOR Reduction (vph)	0	0	0	0	322	17	0	0	0	0	25	0
Lane Group Flow (vph)	0	0	0	421	284	588	32	789	0	0	1670	0
Heavy Vehicles (%)	0%	0%	0%	3%	0%	4%	7%	2%	0%	3%	3%	0%
Turn Type				custom		custom	pm+pt					
Protected Phases				8	8	1	5	2			6	
Permitted Phases				8		8	2					
Actuated Green, G (s)				31.4	31.4	62.2	38.6	35.3			62.8	
Effective Green, g (s)				31.4	31.4	62.2	38.6	35.3			62.8	
Actuated g/C Ratio				0.29	0.29	0.57	0.35	0.32			0.57	
Clearance Time (s)				5.0	5.0	2.5	2.5	5.0			5.0	
Vehicle Extension (s)				3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)				500	421	868	115	1195			2044	
v/s Ratio Prot				c0.24	0.19	c0.19	0.01	0.21			c0.47	
v/s Ratio Perm						0.21	0.09					
v/c Ratio				0.84	0.68	0.68	0.28	0.66			0.82	
Uniform Delay, d1				37.0	34.8	16.8	48.8	32.2			19.0	
Progression Factor				1.00	1.00	1.00	1.35	0.61			0.60	
Incremental Delay, d2				12.2	4.3	2.1	0.9	1.9			2.9	
Delay (s)				49.2	39.0	18.9	66.6	21.7			14.3	
Level of Service				D	D	B	E	C			B	
Approach Delay (s)		0.0			34.2			23.4			14.3	
Approach LOS		A			C			C			B	

Intersection Summary			
HCM Average Control Delay	23.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	82.6%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

22: I-35 NB Ramps & Gardner Rd

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	180	0	20	0	0	0	0	600	250	760	870	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0						5.0	5.0	5.0	5.0	
Lane Util. Factor		1.00						1.00	1.00	0.97	0.95	
Frt		0.99						1.00	0.85	1.00	1.00	
Flt Protected		0.96						1.00	1.00	0.95	1.00	
Satd. Flow (prot)		1694						1961	1568	3367	3725	
Flt Permitted		0.96						1.00	1.00	0.95	1.00	
Satd. Flow (perm)		1694						1961	1568	3367	3725	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	189	0	21	0	0	0	0	632	263	800	916	0
RTOR Reduction (vph)	0	3	0	0	0	0	0	0	147	0	0	0
Lane Group Flow (vph)	0	207	0	0	0	0	0	632	116	800	916	0
Heavy Vehicles (%)	6%	0%	5%	0%	0%	0%	0%	2%	3%	4%	2%	0%
Turn Type	Split								Perm	Prot		
Protected Phases	4	4						2		1	6	
Permitted Phases									2			
Actuated Green, G (s)		16.8						48.5	48.5	29.7	83.2	
Effective Green, g (s)		16.8						48.5	48.5	29.7	83.2	
Actuated g/C Ratio		0.15						0.44	0.44	0.27	0.76	
Clearance Time (s)		5.0						5.0	5.0	5.0	5.0	
Vehicle Extension (s)		3.0						3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)		259						865	691	909	2817	
v/s Ratio Prot		c0.12						c0.32		c0.24	0.25	
v/s Ratio Perm									0.07			
v/c Ratio		0.80						0.73	0.17	0.88	0.33	
Uniform Delay, d1		45.0						25.4	18.6	38.4	4.3	
Progression Factor		1.00						0.93	1.34	0.89	0.73	
Incremental Delay, d2		15.6						4.8	0.5	6.2	0.2	
Delay (s)		60.5						28.4	25.4	40.4	3.3	
Level of Service		E						C	C	D	A	
Approach Delay (s)		60.5			0.0			27.5			20.6	
Approach LOS		E			A			C			C	

Intersection Summary			
HCM Average Control Delay	25.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	82.6%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

23: E 191st Street & Gardner Rd

PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	30	140	710	20	60	830
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		5.0			5.0
Lane Util. Factor	1.00		1.00			1.00
Frt	0.89		1.00			1.00
Flt Protected	0.99		1.00			1.00
Satd. Flow (prot)	1613		1857			1850
Flt Permitted	0.99		1.00			0.91
Satd. Flow (perm)	1613		1857			1686
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	32	147	747	21	63	874
RTOR Reduction (vph)	135	0	1	0	0	0
Lane Group Flow (vph)	44	0	767	0	0	937
Heavy Vehicles (%)	3%	4%	2%	0%	7%	2%
Turn Type					Perm	
Protected Phases	8		2			6
Permitted Phases					6	
Actuated Green, G (s)	8.9		91.1			91.1
Effective Green, g (s)	8.9		91.1			91.1
Actuated g/C Ratio	0.08		0.83			0.83
Clearance Time (s)	5.0		5.0			5.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	131		1538			1396
v/s Ratio Prot	c0.03		0.41			
v/s Ratio Perm						c0.56
v/c Ratio	0.34		0.50			0.67
Uniform Delay, d1	47.8		2.8			3.7
Progression Factor	1.00		1.00			1.38
Incremental Delay, d2	1.5		0.3			2.5
Delay (s)	49.3		3.0			7.5
Level of Service	D		A			A
Approach Delay (s)	49.3		3.0			7.5
Approach LOS	D		A			A

Intersection Summary			
HCM Average Control Delay	9.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	108.4%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

24: Sunflower Road & US 56

PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	90	10	370	30	10	10	110	290	10	170	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.99			1.00			0.90			1.00	
Flt Protected		1.00			0.96			1.00			1.00	
Satd. Flow (prot)		1857			1764			1631			1805	
Flt Permitted		1.00			0.67			0.99			0.97	
Satd. Flow (perm)		1857			1241			1621			1764	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	95	11	389	32	11	11	116	305	11	179	5
RTOR Reduction (vph)	0	4	0	0	1	0	0	95	0	0	1	0
Lane Group Flow (vph)	0	102	0	0	431	0	0	337	0	0	194	0
Heavy Vehicles (%)	0%	1%	0%	3%	0%	0%	0%	9%	4%	0%	5%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		32.4			32.4			47.6			47.6	
Effective Green, g (s)		32.4			32.4			47.6			47.6	
Actuated g/C Ratio		0.36			0.36			0.53			0.53	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		669			447			857			933	
v/s Ratio Prot		0.05										
v/s Ratio Perm					c0.35			c0.21			0.11	
v/c Ratio		0.15			0.96			0.39			0.21	
Uniform Delay, d1		19.5			28.2			12.6			11.2	
Progression Factor		1.00			1.00			1.27			1.36	
Incremental Delay, d2		0.1			33.1			1.3			0.5	
Delay (s)		19.6			61.3			17.3			15.7	
Level of Service		B			E			B			B	
Approach Delay (s)		19.6			61.3			17.3			15.7	
Approach LOS		B			E			B			B	

Intersection Summary			
HCM Average Control Delay	33.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)

25: US 56 & 4th Street

PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	320	130	90	460	150	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0			5.0	5.0	
Lane Util. Factor	1.00			1.00	1.00	
Frt	0.96			1.00	0.95	
Flt Protected	1.00			0.99	0.97	
Satd. Flow (prot)	1753			1833	1715	
Flt Permitted	1.00			0.86	0.97	
Satd. Flow (perm)	1753			1581	1715	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	337	137	95	484	158	95
RTOR Reduction (vph)	13	0	0	0	27	0
Lane Group Flow (vph)	461	0	0	579	226	0
Heavy Vehicles (%)	5%	2%	2%	3%	2%	2%
Turn Type			Perm			
Protected Phases	4			8	2	
Permitted Phases			8			
Actuated Green, G (s)	63.1			63.1	16.9	
Effective Green, g (s)	63.1			63.1	16.9	
Actuated g/C Ratio	0.70			0.70	0.19	
Clearance Time (s)	5.0			5.0	5.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	1229			1108	322	
v/s Ratio Prot	0.26				c0.13	
v/s Ratio Perm				c0.37		
v/c Ratio	0.38			0.52	0.70	
Uniform Delay, d1	5.5			6.3	34.2	
Progression Factor	1.00			1.97	1.00	
Incremental Delay, d2	0.9			1.2	6.8	
Delay (s)	6.3			13.7	41.0	
Level of Service	A			B	D	
Approach Delay (s)	6.3			13.7	41.0	
Approach LOS	A			B	D	

Intersection Summary			
HCM Average Control Delay	16.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	80.3%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner IMF Operations - (Improved + Mitigated) - PM Peak Hour - Synchro Intersection LOS

26: 199th Street & Four Corners Road

PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	10	390	420	130	120	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0		5.0	
Lane Util. Factor		1.00	1.00		1.00	
Frt		1.00	0.97		0.99	
Flt Protected		1.00	1.00		0.95	
Satd. Flow (prot)		1842	1475		909	
Flt Permitted		0.99	1.00		0.95	
Satd. Flow (perm)		1818	1475		909	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	11	411	442	137	126	5
RTOR Reduction (vph)	0	0	15	0	2	0
Lane Group Flow (vph)	0	422	564	0	129	0
Heavy Vehicles (%)	40%	2%	2%	98%	100%	60%
Turn Type	Perm					
Protected Phases		4	8		6	
Permitted Phases	4					
Actuated Green, G (s)		32.8	32.8		10.3	
Effective Green, g (s)		32.8	32.8		10.3	
Actuated g/C Ratio		0.62	0.62		0.19	
Clearance Time (s)		5.0	5.0		5.0	
Vehicle Extension (s)		3.0	3.0		3.0	
Lane Grp Cap (vph)		1123	911		176	
v/s Ratio Prot			c0.38		c0.14	
v/s Ratio Perm		0.23				
v/c Ratio		0.38	0.62		0.73	
Uniform Delay, d1		5.1	6.3		20.1	
Progression Factor		1.00	1.00		1.00	
Incremental Delay, d2		0.2	1.3		14.4	
Delay (s)		5.3	7.5		34.5	
Level of Service		A	A		C	
Approach Delay (s)		5.3	7.5		34.5	
Approach LOS		A	A		C	

Intersection Summary			
HCM Average Control Delay	9.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	53.1	Sum of lost time (s)	10.0
Intersection Capacity Utilization	45.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

27: 199th Street & Gardner Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	150	20	30	210	330	10	130	30	440	200	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00		1.00		1.00	1.00	1.00
Frt	1.00	0.98		1.00	1.00	0.85		0.98		1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		1.00		0.95	1.00	1.00
Satd. Flow (prot)	1805	1803		1752	1827	1583		1798		1770	1863	1568
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.98		0.53	1.00	1.00
Satd. Flow (perm)	1805	1803		1752	1827	1583		1768		991	1863	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	158	21	32	221	347	11	137	32	463	211	32
RTOR Reduction (vph)	0	6	0	0	0	276	0	8	0	0	0	13
Lane Group Flow (vph)	21	173	0	32	221	71	0	172	0	463	211	19
Heavy Vehicles (%)	0%	4%	0%	3%	4%	2%	0%	3%	3%	2%	2%	3%
Turn Type	Prot			Prot		Perm	Perm			pm+pt		Perm
Protected Phases	5	2		1	6			8		7	4	
Permitted Phases						6	8			4		4
Actuated Green, G (s)	3.1	14.7		6.9	18.5	18.5		31.5		53.4	53.4	53.4
Effective Green, g (s)	3.1	14.7		6.9	18.5	18.5		31.5		53.4	53.4	53.4
Actuated g/C Ratio	0.03	0.16		0.08	0.21	0.21		0.35		0.59	0.59	0.59
Clearance Time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	62	294		134	376	325		619		734	1105	930
v/s Ratio Prot	0.01	c0.10		0.02	c0.12					c0.12	0.11	
v/s Ratio Perm						0.05		0.10		c0.26		0.01
v/c Ratio	0.34	0.59		0.24	0.59	0.22		0.28		0.63	0.19	0.02
Uniform Delay, d1	42.4	34.9		39.1	32.3	29.7		21.1		10.9	8.4	7.5
Progression Factor	0.91	1.02		1.00	1.00	1.00		1.00		1.00	1.00	1.00
Incremental Delay, d2	3.2	3.0		0.9	2.3	0.3		1.1		1.8	0.4	0.0
Delay (s)	41.9	38.5		40.0	34.7	30.1		22.2		12.7	8.8	7.6
Level of Service	D	D		D	C	C		C		B	A	A
Approach Delay (s)		38.8			32.3			22.2			11.3	
Approach LOS		D			C			C			B	

Intersection Summary			
HCM Average Control Delay	23.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	64.6%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

30: US-56 & I-35 NB Loop

PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	1530	1330	0	1910	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	1611	1400	0	2011	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked					0.59	
vC, conflicting volume			3011		2616	805
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			3011		2353	805
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			116		18	330

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	805	805	1400	1005	1005
Volume Left	0	0	0	0	0
Volume Right	0	0	1400	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.47	0.47	0.82	0.59	0.59
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	85.7%	ICU Level of Service	E
Analysis Period (min)	15		

37: 199th Street & West Waverley

PM Peak Hour

Movement	EBL	EBT	WBU	WBT	WBR	SWL	SWR
Lane Configurations							
Volume (vph)	5	800	0	840	120	160	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0		5.0	
Lane Util. Factor	1.00	1.00		1.00		1.00	
Frt	1.00	1.00		0.98		1.00	
Flt Protected	0.95	1.00		1.00		0.95	
Satd. Flow (prot)	1805	1624		1528		1487	
Flt Permitted	0.16	1.00		1.00		0.95	
Satd. Flow (perm)	311	1624		1528		1487	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	5	870	0	913	130	174	5
RTOR Reduction (vph)	0	0	0	5	0	1	0
Lane Group Flow (vph)	5	870	0	1038	0	178	0
Heavy Vehicles (%)	0%	17%	2%	17%	57%	22%	0%
Turn Type	Perm		Perm				
Protected Phases		4		8		6	
Permitted Phases	4		8				
Actuated Green, G (s)	65.7	65.7		65.7		14.3	
Effective Green, g (s)	65.7	65.7		65.7		14.3	
Actuated g/C Ratio	0.73	0.73		0.73		0.16	
Clearance Time (s)	5.0	5.0		5.0		5.0	
Vehicle Extension (s)	3.0	3.0		3.0		3.0	
Lane Grp Cap (vph)	227	1186		1115		236	
v/s Ratio Prot		0.54		c0.68		c0.12	
v/s Ratio Perm	0.02						
v/c Ratio	0.02	0.73		0.93		0.75	
Uniform Delay, d1	3.3	7.1		10.2		36.2	
Progression Factor	1.00	1.00		0.72		1.00	
Incremental Delay, d2	0.2	4.0		10.2		12.8	
Delay (s)	3.5	11.1		17.5		49.0	
Level of Service	A	B		B		D	
Approach Delay (s)		11.1		17.5		49.0	
Approach LOS		B		B		D	

Intersection Summary			
HCM Average Control Delay	17.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	69.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner IMF Operations - (Improved + Mitigated) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)
38: 199th Street & IH-35 SB Ramp — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	740	220	120	150	0	0	0	0	10	0	810
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		1.00		1.00	1.00					1.00		1.00
Frt		0.97		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		1572		1752	1743					1805		1302
Flt Permitted		1.00		0.07	1.00					0.95		1.00
Satd. Flow (perm)		1572		124	1743					1805		1302
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	804	239	130	163	0	0	0	0	11	0	880
RTOR Reduction (vph)	0	11	0	0	0	0	0	0	0	0	0	611
Lane Group Flow (vph)	0	1032	0	130	163	0	0	0	0	11	0	269
Heavy Vehicles (%)	0%	21%	4%	3%	9%	0%	0%	0%	0%	0%	0%	24%
Turn Type				pm+pt						Prot		custom
Protected Phases		4		3	8					6		
Permitted Phases				8								3 6
Actuated Green, G (s)		54.7		75.0	75.0					5.0		25.3
Effective Green, g (s)		54.7		75.0	75.0					5.0		25.3
Actuated g/C Ratio		0.61		0.83	0.83					0.06		0.28
Clearance Time (s)		5.0		5.0	5.0					5.0		
Vehicle Extension (s)		3.0		3.0	3.0					3.0		
Lane Grp Cap (vph)		955		380	1453					100		366
v/s Ratio Prot		c0.66		0.06	0.09					0.01		
v/s Ratio Perm				0.23								c0.21
v/c Ratio		1.08		0.34	0.11					0.11		0.73
Uniform Delay, d1		17.6		18.2	1.4					40.4		29.3
Progression Factor		1.03		0.75	0.88					1.00		1.00
Incremental Delay, d2		49.1		0.5	0.0					0.5		7.5
Delay (s)		67.3		14.2	1.2					40.9		36.8
Level of Service		E		B	A					D		D
Approach Delay (s)		67.3			7.0			0.0			36.8	
Approach LOS		E			A			A			D	

Intersection Summary			
HCM Average Control Delay	47.2	HCM Level of Service	D
HCM Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	74.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)
39: 199th Street & IH-35 NB Ramp — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	650	90	0	0	200	20	70	0	50	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0		5.0			
Lane Util. Factor	1.00	1.00			1.00		1.00		1.00			
Frt	1.00	1.00			0.99		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1456	1792			1795		1641		1583			
Flt Permitted	0.45	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	691	1792			1795		1641		1583			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	707	98	0	0	217	22	76	0	54	0	0	0
RTOR Reduction (vph)	0	0	0	0	3	0	0	0	49	0	0	0
Lane Group Flow (vph)	707	98	0	0	236	0	76	0	5	0	0	0
Heavy Vehicles (%)	24%	6%	0%	0%	5%	0%	10%	0%	2%	0%	0%	0%
Turn Type	pm+pt						custom		custom			
Protected Phases	7	4			8							
Permitted Phases	4						2		2			
Actuated Green, G (s)	71.6	71.6			30.1		8.4		8.4			
Effective Green, g (s)	71.6	71.6			30.1		8.4		8.4			
Actuated g/C Ratio	0.80	0.80			0.33		0.09		0.09			
Clearance Time (s)	5.0	5.0			5.0		5.0		5.0			
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Lane Grp Cap (vph)	860	1426			600		153		148			
v/s Ratio Prot	c0.33	0.05			0.13							
v/s Ratio Perm	c0.32						c0.05		0.00			
v/c Ratio	0.82	0.07			0.39		0.50		0.03			
Uniform Delay, d1	5.9	2.0			22.9		38.8		37.1			
Progression Factor	0.63	0.03			0.45		1.00		1.00			
Incremental Delay, d2	0.6	0.0			0.4		2.5		0.1			
Delay (s)	4.3	0.1			10.8		41.3		37.2			
Level of Service	A	A			B		D		D			
Approach Delay (s)		3.8			10.8			39.6			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	9.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	74.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)
40: 199th Street & East Waverley — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	140	10	5	220	10	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	152	11	5	239	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	820					
pX, platoon unblocked						
vC, conflicting volume			163		408	158
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			163		408	158
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	99
cM capacity (veh/h)			1428		601	893

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	163	245	16
Volume Left	0	5	11
Volume Right	11	0	5
cSH	1700	1428	675
Volume to Capacity	0.10	0.00	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.2	10.5
Lane LOS		A	B
Approach Delay (s)	0.0	0.2	10.5
Approach LOS			B

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	25.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)
80: 191st Street & Driveway A — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	130	10	10	80	40	120
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	141	11	11	87	43	130
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	98				348	54
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	98				348	54
tC, single (s)	5.1				7.4	7.2
tC, 2 stage (s)						
tF (s)	3.1				4.4	4.2
p0 queue free %	87				90	84
cM capacity (veh/h)	1054				425	793

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	152	98	43	130
Volume Left	141	0	43	0
Volume Right	0	87	0	130
cSH	1054	1700	425	793
Volume to Capacity	0.13	0.06	0.10	0.16
Queue Length 95th (ft)	12	0	8	15
Control Delay (s)	8.4	0.0	14.4	10.4
Lane LOS	A		B	B
Approach Delay (s)	8.4	0.0	11.4	
Approach LOS			B	

Intersection Summary			
Average Delay	7.7		
Intersection Capacity Utilization	24.4%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner IMF Operations - (Improved + Mitigated) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)
82: Driveway C & Waverly Road — PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	10	10	5	150	190	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	11	5	163	207	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	383	209	212			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	383	209	212			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	99	100			
cM capacity (veh/h)	621	836	1370			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	11	11	168	212
Volume Left	11	0	5	0
Volume Right	0	11	0	5
cSH	621	836	1370	1700
Volume to Capacity	0.02	0.01	0.00	0.12
Queue Length 95th (ft)	1	1	0	0
Control Delay (s)	10.9	9.4	0.3	0.0
Lane LOS	B	A	A	
Approach Delay (s)	10.1		0.3	0.0
Approach LOS	B			

Intersection Summary			
Average Delay	0.7		
Intersection Capacity Utilization	21.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action - (Improved+Mitigated)
84: 191st Street & Driveway E — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	50	90	0	5	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	54	98	0	5	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	98				152	98
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	98				152	98
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	99
cM capacity (veh/h)	1508				844	964

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	54	98	11
Volume Left	0	0	5
Volume Right	0	0	5
cSH	1508	1700	900
Volume to Capacity	0.00	0.06	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	0.0	9.0
Lane LOS			A
Approach Delay (s)	0.0	0.0	9.0
Approach LOS			A

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	14.7%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Gardner No Action - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_________________________Operational Analysis__________________________________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	3/27/2008 10:25:01 AM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Edgerton Road to Sunflower Road
Jurisdiction:	
Analysis Year:	2010
Description:	NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V	1185	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	329	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	688	pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_________________________LOS and Performance Measures__________________________

Flow rate, vp	688	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	9.8	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_________________________Operational Analysis__________________________________

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/20/2008 1:45:04 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Sunflower Road to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V	1450	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	403	v
Trucks and buses	8	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.962	
Driver population factor, fp	1.00	
Flow rate, vp	838	pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_________________________LOS and Performance Measures__________________________

Flow rate, vp	838	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	12.0	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Gardner No Action - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/20/2008 1:45:04 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Gardner Road to US 56
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	1950	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	542	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1116	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	1116	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	15.9	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/20/2008 1:45:04 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	US 56 to 151st Street
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	3260	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	906	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1847	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	1847	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	67.3	mi/h
Number of lanes, N	2	
Density, D	27.4	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Gardner No Action - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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E-mail:

____Operational Analysis____

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/20/2008 1:45:04 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	151Street to US 56
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

____Flow Inputs and Adjustments____

Volume, V	1490	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	414	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	865	pc/h/ln

____Speed Inputs and Adjustments____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

____LOS and Performance Measures____

Flow rate, vp	865	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	12.4	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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E-mail:

____Operational Analysis____

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/20/2008 1:45:04 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	US 56 to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

____Flow Inputs and Adjustments____

Volume, V	580	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	161	v
Trucks and buses	18	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.917	
Driver population factor, fp	1.00	
Flow rate, vp	351	pc/h/ln

____Speed Inputs and Adjustments____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

____LOS and Performance Measures____

Flow rate, vp	351	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	5.0	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Gardner No Action - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/20/2008 1:45:04 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	Gardner Road to Sunflower Road
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	530	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	147	v
Trucks and buses	18	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.917	
Driver population factor, fp	1.00	
Flow rate, vp	321	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	321	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	4.6	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
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Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	3/27/2008 10:25:01 AM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	Sunflower Road to Edgerton Road
Jurisdiction:	
Analysis Year:	2010
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	495	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	138	v
Trucks and buses	19	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.913	
Driver population factor, fp	1.00	
Flow rate, vp	301	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	301	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	4.3	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Gardner No Action - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	3/27/2008 10:25:01 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Edgerton Road to Sunflower Road
Jurisdiction:	
Analysis Year:	2010
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	695	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	193	v
Trucks and buses	21	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.905	
Driver population factor, fp	1.00	
Flow rate, vp	427	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	427	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	6.1	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/20/2008 1:45:04 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Sunflower Road to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	780	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	217	v
Trucks and buses	19	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.913	
Driver population factor, fp	1.00	
Flow rate, vp	475	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	475	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	6.8	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Gardner No Action - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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E-mail:

____Operational Analysis____

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/20/2008 1:45:04 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Gardner Road to US 56
Jurisdiction:	KDOT
Analysis Year:	2010

Description: NEPA Traffic Study

____Flow Inputs and Adjustments____

Volume, V	970	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	269	v
Trucks and buses	16	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.926	
Driver population factor, fp	1.00	
Flow rate, vp	582	pc/h/ln

____Speed Inputs and Adjustments____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

____LOS and Performance Measures____

Flow rate, vp	582	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	8.3	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
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____Operational Analysis____

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/20/2008 1:45:04 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	US 56 to 151st Street
Jurisdiction:	KDOT
Analysis Year:	2010

Description: NEPA Traffic Study

____Flow Inputs and Adjustments____

Volume, V	1850	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	514	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1079	pc/h/ln

____Speed Inputs and Adjustments____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

____LOS and Performance Measures____

Flow rate, vp	1079	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	15.4	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Gardner No Action - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Level of service, LOS D

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: Fax:
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_____Operational Analysis_____

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/20/2008 1:45:04 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: 151Street to US 56
Jurisdiction: KDOT
Analysis Year: 2010
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	3090	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	858	v
Trucks and buses	7	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.966	
Driver population factor, fp	1.00	
Flow rate, vp	1777	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	1777	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	68.1	mi/h
Number of lanes, N	2	
Density, D	26.1	pc/mi/ln

HCS+: Basic Freeway Segments Release 5.21

Level of service, LOS B

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/20/2008 1:45:04 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: US 56 to Gardner Road
Jurisdiction: KDOT
Analysis Year: 2010
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	2080	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	578	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1208	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	1208	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	17.3	pc/mi/ln

2010 Gardner No Action - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/20/2008 1:45:04 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: Gardner Road to Sunflower Road
Jurisdiction: KDOT
Analysis Year: 2010
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	1630	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	453	v
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.948	
Driver population factor, fp	1.00	
Flow rate, vp	955	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	955	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	13.6	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 3/27/2008 10:25:01 AM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: Sunflower Road to Edgerton Road
Jurisdiction:
Analysis Year: 2010
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	1380	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	383	v
Trucks and buses	13	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.939	
Driver population factor, fp	1.00	
Flow rate, vp	817	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	817	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	11.7	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Gardner No Action - AM Peak Hour - HCS Freeway Ramps

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                HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                      Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:25:01 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1185           vph

________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              15             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1185        15                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                329         4                   v
Trucks and buses                       9           7                   %
Recreational vehicles                  0           0                   %
Terrain type:                          Level       Rolling
    Grade                              0.00    %   0.00    %           %
    Length                             0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.957       0.905
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1376        18                      pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1376   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks__________________________________

                             Actual        Maximum         LOS F?
     v  = v                  1376          4800            No
      Fi   F
     v  = v - v              1358          4800            No
      FO   F   R
     v                       18            2000            No
      R
     v     v                 0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?            No
      3 or  av34
Is   v     v       > 1.5 v  /2             No
      3 or  av34          12
If yes, v    =                             (Equation 25-18)
         12A

_____________________Flow Entering Diverge Influence Area_____________________
                        Actual        Max Desirable          Violation?
     v                  1376          4600                   No
      12                                                                       !
_________________Level of Service Determination (if not F)____________________

Density,            D = 4.252 + 0.0086 v  - 0.009  L   =    8.9     pc/mi/ln
                     R                  12          D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,               D  = 0.430
                                            S
Space mean speed in ramp influence area,   S  = 58.0    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 58.0    mph
_______________________________________________________________________________
```

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                HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                      Fax:
E-mail:

________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:25:01 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1170           vph

_________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              280            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1170        280                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                325         78                  v
Trucks and buses                       9           1                   %
Recreational vehicles                  0           0                   %
Terrain type:                          Level       Rolling
    Grade                                      %           %           %
    Length                                     mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.957       0.985
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1359        316                     pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1359   pc/h
                   12   F   FM

______________________________Capacity Checks__________________________________

                             Actual        Maximum         LOS F?
     v                       1675          4800            No
      FO
     v     v                 0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?            No
      3 or  av34
Is   v     v       > 1.5 v  /2             No
      3 or  av34          12
If yes, v    =                             (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area_____________________
                        Actual        Max Desirable          Violation?
     v                  1359          4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =    13.4    pc/mi/ln
          R                   R           12          A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,               M  = 0.286
                                            S
Space mean speed in ramp influence area,   S  = 62.0    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 62.0    mph
_______________________________________________________________________________
```

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                        HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                        Fax:
E-mail:

____________________________________Diverge Analysis________________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          3/20/2008 1:45:04 PM
Analysis time period:    AM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                3 Gardner Exit
Jurisdiction:            KDOT
Analysis Year:           2010
Description:  NEPA Traffic Study

_____________________________________Freeway Data___________________________________

Type of analysis                             Diverge
Number of lanes in freeway                   2
Free-flow speed on freeway                   70.0            mph
Volume on freeway                            1450            vph

____________________________________Off Ramp Data___________________________________

Side of freeway                              Right
Number of lanes in ramp                      1
Free-Flow speed on ramp                      35.0            mph
Volume on ramp                               90              vph
Length of first accel/decel lane             800             ft
Length of second accel/decel lane                            ft

___________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                    No
Volume on adjacent ramp                                      vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                    ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1450        90                    vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 403         25                    v
Trucks and buses                        8           2                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %             %
     Length                             0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.962       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1676        103                      pcph

_________________________Estimation of V12 Diverge Areas________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1676   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                1676          4800            No
      Fi   F
     v  = v - v            1573          4800            No
      FO   F   R
     v                     103           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual       Max Desirable         Violation?
     v                1676         4600                  No
      12                                                                        !
________________Level of Service Determination (if not F)_____________________

Density,           D = 4.252 + 0.0086 v  - 0.009  L   =   11.5    pc/mi/ln
                                       R             12         D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                 D  = 0.437
                                              S
Space mean speed in ramp influence area,     S  = 57.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.8    mph
________________________________________________________________________________
```

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Phone:                                        Fax:
E-mail:

____________________________________Merge Analysis__________________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          3/20/2008 1:45:04 PM
Analysis time period:    AM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                4 Gardner Entr
Jurisdiction:            KDOT
Analysis Year:           2010
Description:  NEPA Traffic Study

_____________________________________Freeway Data___________________________________

Type of analysis                             Merge
Number of lanes in freeway                   2
Free-flow speed on freeway                   70.0            mph
Volume on freeway                            1360            vph

_____________________________________On Ramp Data___________________________________

Side of freeway                              Right
Number of lanes in ramp                      1
Free-Flow speed on ramp                      35.0            mph
Volume on ramp                               590             vph
Length of first accel/decel lane             800             ft
Length of second accel/decel lane                            ft

___________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                    No
Volume on adjacent Ramp                                      vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                    ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1360        590                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 378         164                   v
Trucks and buses                        8           2                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                                      %           %             %
     Length                                     mi          mi            mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.962       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1572        675                      pcph

_________________________Estimation of V12 Merge Areas__________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1572   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     2247          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual       Max Desirable         Violation?
     v                1572         4400                  No
      12                                                                        !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   17.7    pc/mi/ln
                              R             12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                 M  = 0.302
                                              S
Space mean speed in ramp influence area,     S  = 61.5    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.5    mph
________________________________________________________________________________
```

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1950          vph

_________________________________Off Ramp Data___________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            240           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1950        240                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               542         67                    v
Trucks and buses                      6           7                     %
Recreational vehicles                 0           0                     %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %             %
     Length                           0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.971       0.905
Driver population factor, fP          1.00        1.00
Flow rate, vp                         2232        295                   pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2232   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                2232          4800            No
      Fi   F
     v  = v - v            1937          4800            No
      FO   F   R
     v                     295           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                2232          4600                   No
      12                                                                      !
________________Level of Service Determination (if not F)______________________

Density,            D = 4.252 + 0.0086 v  - 0.009  L   =   16.2    pc/mi/ln
                                        R            12       D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation___________________________________

Intermediate speed variable,                 D  = 0.455
                                              S
Space mean speed in ramp influence area,     S  = 57.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.3    mph
________________________________________________________________________________
```

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         3129          vph

__________________________________On Ramp Data___________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            131           vph
Length of first accel/decel lane          1000          ft
Length of second accel/decel lane                       ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       3129        131                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               869         36                    v
Trucks and buses                      6           2                     %
Recreational vehicles                 0           0                     %
Terrain type:                         Level       Rolling
     Grade                                    %           %             %
     Length                                   mi          mi            mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.971       0.971
Driver population factor, fP          1.00        1.00
Flow rate, vp                         3581        150                   pcph

_________________________Estimation of V12 Merge Areas__________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  3581   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     3731          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                3581          4400                   No
      12                                                                      !
________________Level of Service Determination (if not F)______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   28.2    pc/mi/ln
                              R            12           A
Level of service for ramp-freeway junction areas of influence  D

______________________________Speed Estimation___________________________________

Intermediate speed variable,                 M  = 0.414
                                              S
Space mean speed in ramp influence area,     S  = 58.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 58.4    mph
________________________________________________________________________________
```

```
                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         1710           vph

__________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0           mph
Volume on ramp                            1419           vph
Length of first accel/decel lane          500            ft
Length of second accel/decel lane                        ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1710        1419                 vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               475         394                  v
Trucks and buses                      6           2                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.971       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1957        1624                    pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1957   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     3581          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v     =                          (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1957          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   29.5    pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  D

______________________________Speed Estimation_________________________________

Intermediate speed variable,                 M  = 0.426
                                              S
Space mean speed in ramp influence area,     S  = 58.1    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 58.1    mph
_______________________________________________________________________________
```

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                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               8 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         1490           vph

_________________________________Off Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   45.0           mph
Volume on ramp                            970            vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1490        970                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               414         269                  v
Trucks and buses                      9           3                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %           %
     Length                           0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.957       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1730        1126                    pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1730   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1730          4800            No
      Fi   F
     v  = v - v            604           4800            No
      FO   F   R
     v                     1126          2100            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v     =                          (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1730          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =    11.9    pc/mi/ln
                                          R           12          D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation_________________________________

Intermediate speed variable,                 D  = 0.399
                                              S
Space mean speed in ramp influence area,     S  = 58.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 58.8    mph
_______________________________________________________________________________
```

2010 Gardner No Action - AM Peak Hour - HCS Freeway Ramps

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                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis_________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               9 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         520           vph

__________________________________On Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            60            vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        520         60                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                144         17                   v
Trucks and buses                       9           17                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.957       0.797
Driver population factor, fP           1.00        1.00
Flow rate, vp                          604         84                   pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  604    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     688           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                604           4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   5.8      pc/mi/ln
          R                   R            12             A
Level of service for ramp-freeway junction areas of influence  A

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.273
                                              S
Space mean speed in ramp influence area,     S  = 62.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.4    mph
_______________________________________________________________________________
```

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                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis_______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         580           vph

_________________________________Off Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            100           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        580         100                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                161         28                   v
Trucks and buses                       18          13                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %           %
     Length                            0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.917       0.837
Driver population factor, fP           1.00        1.00
Flow rate, vp                          702         133                  pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  702    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                702           4800            No
      Fi   F
     v  = v - v            569           4800            No
      FO   F   R
     v                     133           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                702           4600                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =    3.1      pc/mi/ln
                                          R          12           D
Level of service for ramp-freeway junction areas of influence A

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.440
                                              S
Space mean speed in ramp influence area,     S  = 57.7    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.7    mph
_______________________________________________________________________________
```

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Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Trishul Palekar
Agency/Co.:	HDR Inc.
Date performed:	3/20/2008 1:45:04 PM
Analysis time period:	AM
Freeway/Dir of Travel:	I-35 Southbound
Junction:	11 Gardner Entr
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	480	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	50	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	480	50		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	133	14		v
Trucks and buses	18	4		%
Recreational vehicles	0	0		%
Terrain type:	Level	Rolling		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5*	2.5		
Recreational vehicle PCE, ER	1.2*	2.0		
Heavy vehicle adjustment, fHV	0.917	0.943		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	581	59		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 581 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	640	4800	No
v_3 or v_{av34}	0 pc/h	(Equation 25-4 or 25-5)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		No	
If yes, v_{12A} =		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	581	4400	No

!

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 5.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable,	M_S = 0.272	
Space mean speed in ramp influence area,	S_R = 62.4	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 62.4	mph

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Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Tom Hiles
Agency/Co.:	HDR Inc.
Date performed:	3/27/2008 10:25:01 AM
Analysis time period:	AM
Freeway/Dir of Travel:	I-35 Southbound
Junction:	12 Sunflower Exit
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	530	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	50	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	530	50		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	147	14		v
Trucks and buses	18	4		%
Recreational vehicles	0	0		%
Terrain type:	Level	Rolling		
Grade	0.00 %	0.00 %	%	
Length	0.00 mi	0.00 mi	mi	
Trucks and buses PCE, ET	1.5*	2.5		
Recreational vehicle PCE, ER	1.2*	2.0		
Heavy vehicle adjustment, fHV	0.917	0.943		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	642	59		pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 642 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	642	4800	No
$v_{FO} = v_F - v_R$	583	4800	No
v_R	59	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		No	
If yes, v_{12A} =		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	642	4600	No

!

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ = 2.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable,	D_S = 0.433	
Space mean speed in ramp influence area,	S_R = 57.9	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 57.9	mph

2010 Gardner No Action - AM Peak Hour - HCS Freeway Ramps

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                HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:25:01 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           480            vph

__________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              15             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        480         15                    vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                133         4                     v
Trucks and buses                       18          0                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.917       1.000
Driver population factor, fP           1.00        1.00
Flow rate, vp                          581         17                        pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L   =            (Equation 25-2 or 25-3)
                   EQ
                  P   =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  581    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     598           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v     > 2700 pc/h?            No
      3 or  av34
Is   v     v     > 1.5 v  /2             No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                581           4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   5.1     pc/mi/ln
          R                  R            12            A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.272
                                              S
Space mean speed in ramp influence area,     S  = 62.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.4    mph
_______________________________________________________________________________
```

2010 Gardner No Action - PM Peak Hour - HCS Freeway Ramps

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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:25:01 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         695           vph

________________________________Off Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            15            vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

___________________Conversion to pc/h Under Base Conditions__________________

Junction Components                 Freeway     Ramp        Adjacent
                                                            Ramp
Volume, V (vph)                     695         15                   vph
Peak-hour factor, PHF               0.90        0.90
Peak 15-min volume, v15             193         4                    v
Trucks and buses                    20          0                    %
Recreational vehicles               0           0                    %
Terrain type:                       Level       Rolling
     Grade                          0.00    %   0.00    %            %
     Length                         0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET            1.5*        2.5
Recreational vehicle PCE, ER        1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.909       1.000
Driver population factor, fP           1.00        1.00
Flow rate, vp                          849         17                      pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  849    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v  = v                849           4800            No
      Fi   F
     v  = v - v            832           4800            No
      FO   F   R
     v                     17            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                849           4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   4.4     pc/mi/ln
                                  R             12       D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                 D  = 0.430
                                              S
Space mean speed in ramp influence area,     S  = 58.0    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 58.0    mph
______________________________________________________________________________
```

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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:25:01 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         680           vph

_________________________________On Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            100           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

___________________Conversion to pc/h Under Base Conditions__________________

Junction Components                 Freeway     Ramp        Adjacent
                                                            Ramp
Volume, V (vph)                     680         100                  vph
Peak-hour factor, PHF               0.90        0.90
Peak 15-min volume, v15             189         28                   v
Trucks and buses                    20          4                    %
Recreational vehicles               0           0                    %
Terrain type:                       Level       Rolling
     Grade                                  %           %            %
     Length                                 mi          mi           mi
Trucks and buses PCE, ET            1.5*        2.5
Recreational vehicle PCE, ER        1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.909       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          831         118                     pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  831    pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v                     949           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                831           4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   7.8     pc/mi/ln
                              R            12            A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                 M  = 0.275
                                              S
Space mean speed in ramp influence area,     S  = 62.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.3    mph
______________________________________________________________________________
```

2010 Gardner No Action - PM Peak Hour - HCS Freeway Ramps

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                 HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_______________________________Diverge Analysis______________________________

Analyst:               Tom Hiles
Agency/Co.:            HDR Inc.
Date performed:        3/27/2008 10:25:01 AM
Analysis time period:  PM
Freeway/Dir of Travel: I-35 Northbound
Junction:              3 Gardner Exit
Jurisdiction:          KDOT
Analysis Year:         2010
Description:  NEPA Traffic Study

________________________________Freeway Data_________________________________

Type of analysis                         Diverge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0           mph
Volume on freeway                        780            vph

_______________________________Off Ramp Data_________________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-Flow speed on ramp                  35.0           mph
Volume on ramp                           60             vph
Length of first accel/decel lane         800            ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

__________________Conversion to pc/h Under Base Conditions__________________

Junction Components                  Freeway     Ramp        Adjacent
                                                             Ramp
Volume, V (vph)                      780         60                   vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              217         17                   v
Trucks and buses                     18          7                    %
Recreational vehicles                0           0                    %
Terrain type:                        Level       Rolling
    Grade                            0.00    %   0.00    %            %
    Length                           0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
Heavy vehicle adjustment, fHV        0.917       0.905
Driver population factor, fP         1.00        1.00
Flow rate, vp                        945         74                     pcph

________________________Estimation of V12 Diverge Areas_____________________

                 L  =            (Equation 25-8 or 25-9)
                  EQ
                 P  =    1.000   Using Equation  0
                  FD
                 v  = v  + (v - v ) P  =  945    pc/h
                  12   R     F   R   FD

______________________________Capacity Checks_______________________________

                             Actual        Maximum         LOS F?
     v  = v                  945           4800            No
      Fi   F
     v  = v - v              871           4800            No
      FO   F   R
     v                       74            2000            No
      R
     v     v                 0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?             No
      3 or  av34
Is   v     v      > 1.5 v  /2              No
      3 or  av34         12
If yes, v   =                              (Equation 25-18)
         12A

_____________________Flow Entering Diverge Influence Area___________________
                       Actual        Max Desirable         Violation?
     v                 945           4600                  No
      12                                                                    !
________________Level of Service Determination (if not F)___________________

Density,            D = 4.252 + 0.0086 v  - 0.009  L   =   5.2     pc/mi/ln
                     R                  12          D
Level of service for ramp-freeway junction areas of influence A

____________________________Speed Estimation________________________________

Intermediate speed variable,               D  = 0.435
                                            S
Space mean speed in ramp influence area,   S  = 57.8    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 57.8    mph
____________________________________________________________________________
```

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                 HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_______________________________Merge Analysis________________________________

Analyst:               Tom Hiles
Agency/Co.:            HDR Inc.
Date performed:        3/27/2008 10:25:01 AM
Analysis time period:  PM
Freeway/Dir of Travel: I-35 Northbound
Junction:              4 Gardner Entr
Jurisdiction:          KDOT
Analysis Year:         2010
Description:  NEPA Traffic Study

________________________________Freeway Data_________________________________

Type of analysis                         Merge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0           mph
Volume on freeway                        720            vph

________________________________On Ramp Data_________________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-flow speed on ramp                  35.0           mph
Volume on ramp                           250            vph
Length of first accel/decel lane         800            ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

__________________Conversion to pc/h Under Base Conditions__________________

Junction Components                  Freeway     Ramp        Adjacent
                                                             Ramp
Volume, V (vph)                      720         250                  vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              200         69                   v
Trucks and buses                     18          6                    %
Recreational vehicles                0           0                    %
Terrain type:                        Level       Rolling
    Grade                                    %           %            %
    Length                                   mi          mi           mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
Heavy vehicle adjustment, fHV        0.917       0.917
Driver population factor, fP         1.00        1.00
Flow rate, vp                        872         303                    pcph

________________________Estimation of V12 Merge Areas_______________________

                 L  =            (Equation 25-2 or 25-3)
                  EQ
                 P  =    1.000   Using Equation  0
                  FM
                 v  = v  (P  ) =  872    pc/h
                  12   F   FM

______________________________Capacity Checks_______________________________

                             Actual        Maximum         LOS F?
     v                       1175          4800            No
      FO
     v     v                 0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?             No
      3 or  av34
Is   v     v      > 1.5 v  /2              No
      3 or  av34         12
If yes, v   =                              (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area___________________
                       Actual        Max Desirable         Violation?
     v                 872           4400                  No
      12                                                                    !
________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   9.5     pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  A

____________________________Speed Estimation________________________________

Intermediate speed variable,               M  = 0.278
                                            S
Space mean speed in ramp influence area,   S  = 62.2    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 62.2    mph
____________________________________________________________________________
```

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                 HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data____________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           970           vph

_________________________________Off Ramp Data____________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              120           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         970         120                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 269         33                   v
Trucks and buses                        16          8                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
    Grade                               0.00    %   0.00    %            %
    Length                              0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.926       0.893
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1164        149                      pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1164   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v  = v                1164          4800            No
      Fi   F
     v  = v - v            1015          4800            No
      FO   F   R
     v                     149           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1164          4600                   No
      12                                                                      !
________________Level of Service Determination (if not F)______________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   7.1     pc/mi/ln
                      R                 12          D
Level of service for ramp-freeway junction areas of influence A

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.441
                                              S
Space mean speed in ramp influence area,     S  = 57.6    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.6    mph
_________________________________________________________________________________
```

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Phone:                                  Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data____________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1826          vph

__________________________________On Ramp Data____________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              24            vph
Length of first accel/decel lane            1000          ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1826        24                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 507         7                    v
Trucks and buses                        16          3                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
    Grade                                       %           %            %
    Length                                      mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.926       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2191        28                       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2191   pc/h
                   12   F   FM

_______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v                     2219          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2191          4400                   No
      12                                                                      !
________________Level of Service Determination (if not F)______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   16.5    pc/mi/ln
                              R           12           A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.287
                                              S
Space mean speed in ramp influence area,     S  = 62.0    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.0    mph
_________________________________________________________________________________
```

```
                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          850           vph

__________________________________On Ramp Data_______________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0          mph
Volume on ramp                             976           vph
Length of first accel/decel lane           500           ft
Length of second accel/decel lane                        ft

_________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        850         976                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                236         271                  v
Trucks and buses                       16          3                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.926       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1020        1133                 pcph

_________________________Estimation of V12 Merge Areas_______________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1020   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     2153          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v          > 2700 pc/h?       No
      3 or  av34
Is   v     v          > 1.5 v  /2        No
      3 or  av34             12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1020          4400                   No
      12                                                                    !
_________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   18.6    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation________________________________

Intermediate speed variable,                 M  = 0.320
                                              S
Space mean speed in ramp influence area,     S  = 61.1    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.1    mph
_____________________________________________________________________________
```

```
                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis____________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               8 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          3090          vph

_________________________________Off Ramp Data_______________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    45.0          mph
Volume on ramp                             1320          vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

_________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        3090        1320                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                858         367                  v
Trucks and buses                       7           2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.966       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3553        1511                 pcph

_________________________Estimation of V12 Diverge Areas_____________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  3553   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v  = v                3553          4800            No
      Fi   F
     v  = v - v            2042          4800            No
      FO   F   R
     v                     1511          2100            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v          > 2700 pc/h?       No
      3 or  av34
Is   v     v          > 1.5 v  /2        No
      3 or  av34             12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable          Violation?
     v                3553          4600                   No
      12                                                                    !
_________________Level of Service Determination (if not F)___________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   27.6    pc/mi/ln
                                         R          12         D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation________________________________

Intermediate speed variable,                 D  = 0.434
                                              S
Space mean speed in ramp influence area,     S  = 57.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.8    mph
_____________________________________________________________________________
```

2010 Gardner No Action - PM Peak Hour - HCS Freeway Ramps

```
                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis_________________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          3/20/2008 1:45:04 PM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Southbound
Junction:                9 US 56 Entr
Jurisdiction:            KDOT
Analysis Year:           2010
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1770          vph

__________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              310           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1770        310                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 492         86                   v
Trucks and buses                        7           3                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                     %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.966       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2035        360                   pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2035   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     2395          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area_______________________
                      Actual        Max Desirable          Violation?
     v                2035          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   19.0    pc/mi/ln
                              R            12            A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation__________________________________

Intermediate speed variable,               M  = 0.308
                                            S
Space mean speed in ramp influence area,   S  = 61.4    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 61.4    mph
________________________________________________________________________________
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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis_______________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          3/20/2008 1:45:04 PM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Southbound
Junction:                10 Gardner Exit
Jurisdiction:            KDOT
Analysis Year:           2010
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2080          vph

_________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              540           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2080        540                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 578         150                  v
Trucks and buses                        9           4                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00   %    0.00   %           %
     Length                             0.00   mi   0.00   mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
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Heavy vehicle adjustment, fHV           0.957       0.943
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2415        636                   pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2415   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                2415          4800            No
      Fi   F
     v  = v - v            1779          4800            No
      FO   F   R
     v                     636           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2415          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,                D = 4.252 + 0.0086 v  - 0.009  L   =   17.8    pc/mi/ln
                                            R          12          D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation__________________________________

Intermediate speed variable,               D  = 0.485
                                            S
Space mean speed in ramp influence area,   S  = 56.4    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 56.4    mph
________________________________________________________________________________
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2010 Gardner No Action - PM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                  Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                         Merge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0          mph
Volume on freeway                        1540          vph

_________________________________On Ramp Data_________________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-flow speed on ramp                  35.0          mph
Volume on ramp                           90            vph
Length of first accel/decel lane         800           ft
Length of second accel/decel lane                      ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                No
Volume on adjacent Ramp                                vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                              ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                 Freeway     Ramp        Adjacent
                                                            Ramp
Volume, V (vph)                     1540        90                  vph
Peak-hour factor, PHF               0.90        0.90
Peak 15-min volume, v15             428         25                  v
Trucks and buses                    9           6                   %
Recreational vehicles               0           0                   %
Terrain type:                       Level       Rolling
     Grade                                  %           %           %
     Length                                 mi          mi          mi
Trucks and buses PCE, ET            1.5*        2.5
Recreational vehicle PCE, ER        1.2*        2.0
Heavy vehicle adjustment, fHV       0.957       0.917
Driver population factor, fP        1.00        1.00
Flow rate, vp                       1788        109                 pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =           (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1788   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum        LOS F?
     v                     1897          4800           No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable        Violation?
     v                1788          4400                 No
      12                                                                    !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   15.2    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                M  = 0.291
                                             S
Space mean speed in ramp influence area,    S  = 61.9    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 61.9    mph
______________________________________________________________________________
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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                  Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:25:01 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                         Diverge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0          mph
Volume on freeway                        1630          vph

________________________________Off Ramp Data_________________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-Flow speed on ramp                  35.0          mph
Volume on ramp                           280           vph
Length of first accel/decel lane         800           ft
Length of second accel/decel lane                      ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                No
Volume on adjacent ramp                                vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                              ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                 Freeway     Ramp        Adjacent
                                                            Ramp
Volume, V (vph)                     1630        280                 vph
Peak-hour factor, PHF               0.90        0.90
Peak 15-min volume, v15             453         78                  v
Trucks and buses                    11          1                   %
Recreational vehicles               0           0                   %
Terrain type:                       Level       Rolling
     Grade                          0.00    %   0.00    %           %
     Length                         0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET            1.5*        2.5
Recreational vehicle PCE, ER        1.2*        2.0
Heavy vehicle adjustment, fHV       0.948       0.985
Driver population factor, fP        1.00        1.00
Flow rate, vp                       1911        316                 pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =           (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1911   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_______________________________

                           Actual        Maximum        LOS F?
     v  = v                1911          4800           No
      Fi   F
     v  = v - v            1595          4800           No
      FO   F   R
     v                     316           2000           No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable        Violation?
     v                1911          4600                 No
      12                                                                    !
_________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   13.5    pc/mi/ln
                        R                  12         D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                D  = 0.456
                                             S
Space mean speed in ramp influence area,    S  = 57.2    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.2    mph
______________________________________________________________________________
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Phone: Fax:
E-mail:

Merge Analysis

Analyst: Tom Hiles
Agency/Co.: HDR Inc.
Date performed: 3/27/2008 10:25:01 AM
Analysis time period: PM
Freeway/Dir of Travel: I-35 Southbound
Junction: 13 Sunflower Entr
Jurisdiction: KDOT
Analysis Year: 2010
Description: NEPA Traffic Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1350	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	30	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1350	30		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	375	8		v
Trucks and buses	11	7		%
Recreational vehicles	0	0		%
Terrain type:	Level	Rolling		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5*	2.5		
Recreational vehicle PCE, ER	1.2*	2.0		
Heavy vehicle adjustment, fHV	0.948	0.905		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	1583	37		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1583 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1620	4800	No
v_{3} or v_{av34}	0 pc/h	(Equation 25-4 or 25-5)	
Is v_{3} or v_{av34} > 2700 pc/h?		No	
Is v_{3} or v_{av34} > 1.5 v_{12} /2		No	
If yes, v_{12A} =		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1583	4400	No

!

Level of Service Determination (if not F)

Density, $D = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 13.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, M_S = 0.285

Space mean speed in ramp influence area, S_R = 62.0 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 62.0 mph

2010 Proposed Action - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 12:59:54 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Edgerton Road to Sunflower Road
Jurisdiction:	
Analysis Year:	2010
Description:	NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	1195	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	332	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	694	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	694	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	9.9	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

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_____Operational Analysis_____

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 12:59:54 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Sunflower Road to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	1460	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	406	v
Trucks and buses	8	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.962	
Driver population factor, fp	1.00	
Flow rate, vp	844	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	844	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	12.1	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Proposed Action - AM Peak Hour - HCS Freeway Mainline

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Phone: Fax:
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Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 12:59:54 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Gardner Road to US 56
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	2070	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	575	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1208	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	1208	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	17.3	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 12:59:54 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	US 56 to 151st Street
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	3380	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	939	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1934	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	1934	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	66.0	mi/h
Number of lanes, N	2	
Density, D	29.3	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Proposed Action - AM Peak Hour - HCS Freeway Mainline

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              HCS+: Basic Freeway Segments Release 5.21

Phone:                                  Fax:
E-mail:

_________________________Operational Analysis__________________________________

Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         4/2/2008 12:59:54 PM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Southbound
From/To:                151Street to US 56
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                  1570          veh/h
Peak-hour factor, PHF                      0.90
Peak 15-min volume, v15                    436           v
Trucks and buses                           11            %
Recreational vehicles                      0             %
Terrain type:                              Level
    Grade                                  0.00          %
    Segment length                         0.00          mi
Trucks and buses PCE, ET                   1.5
Recreational vehicle PCE, ER               1.2
Heavy vehicle adjustment, fHV              0.948
Driver population factor, fp               1.00
Flow rate, vp                              920           pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                 12.0          ft
Right-shoulder lateral clearance           6.0           ft
Interchange density                        0.50          interchange/mi
Number of lanes, N                         2
Free-flow speed:                           Measured
     FFS or BFFS                           70.0          mi/h
Lane width adjustment, fLW                 0.0           mi/h
Lateral clearance adjustment, fLC          0.0           mi/h
Interchange density adjustment, fID        0.0           mi/h
Number of lanes adjustment, fN             0.0           mi/h
Free-flow speed, FFS                       70.0          mi/h
                                           Rural Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                              920           pc/h/ln
Free-flow speed, FFS                       70.0          mi/h
Average passenger-car speed, S             70.0          mi/h
Number of lanes, N                         2
Density, D                                 13.1          pc/mi/ln
Level of service, LOS                      B

  Overall results are not computed when free-flow speed is less than 55 mph.
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              HCS+: Basic Freeway Segments Release 5.21

Phone:                                  Fax:
E-mail:

_________________________Operational Analysis__________________________________

Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         4/2/2008 12:59:54 PM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Southbound
From/To:                US 56 to Gardner Road
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                  670           veh/h
Peak-hour factor, PHF                      0.90
Peak 15-min volume, v15                    186           v
Trucks and buses                           23            %
Recreational vehicles                      0             %
Terrain type:                              Level
    Grade                                  0.00          %
    Segment length                         0.00          mi
Trucks and buses PCE, ET                   1.5
Recreational vehicle PCE, ER               1.2
Heavy vehicle adjustment, fHV              0.897
Driver population factor, fp               1.00
Flow rate, vp                              415           pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                 12.0          ft
Right-shoulder lateral clearance           6.0           ft
Interchange density                        0.50          interchange/mi
Number of lanes, N                         2
Free-flow speed:                           Measured
     FFS or BFFS                           70.0          mi/h
Lane width adjustment, fLW                 0.0           mi/h
Lateral clearance adjustment, fLC          0.0           mi/h
Interchange density adjustment, fID        0.0           mi/h
Number of lanes adjustment, fN             0.0           mi/h
Free-flow speed, FFS                       70.0          mi/h
                                           Rural Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                              415           pc/h/ln
Free-flow speed, FFS                       70.0          mi/h
Average passenger-car speed, S             70.0          mi/h
Number of lanes, N                         2
Density, D                                 5.9           pc/mi/ln
Level of service, LOS                      A

  Overall results are not computed when free-flow speed is less than 55 mph.
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2010 Proposed Action - AM Peak Hour - HCS Freeway Mainline

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                    HCS+: Basic Freeway Segments Release 5.21

Phone:                                      Fax:
E-mail:

_________________________Operational Analysis__________________________________

Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         4/2/2008 12:59:54 PM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Southbound
From/To:                Gardner Road to Sunflower Road
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                   540            veh/h
Peak-hour factor, PHF                       0.90
Peak 15-min volume, v15                     150            v
Trucks and buses                            18             %
Recreational vehicles                       0              %
Terrain type:                               Level
    Grade                                   0.00           %
    Segment length                          0.00           mi
Trucks and buses PCE, ET                    1.5
Recreational vehicle PCE, ER                1.2
Heavy vehicle adjustment, fHV               0.917
Driver population factor, fp                1.00
Flow rate, vp                               327            pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                  12.0           ft
Right-shoulder lateral clearance            6.0            ft
Interchange density                         0.50           interchange/mi
Number of lanes, N                          2
Free-flow speed:                            Measured
     FFS or BFFS                            70.0           mi/h
Lane width adjustment, fLW                  0.0            mi/h
Lateral clearance adjustment, fLC           0.0            mi/h
Interchange density adjustment, fID         0.0            mi/h
Number of lanes adjustment, fN              0.0            mi/h
Free-flow speed, FFS                        70.0           mi/h
                                            Rural Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                               327            pc/h/ln
Free-flow speed, FFS                        70.0           mi/h
Average passenger-car speed, S              70.0           mi/h
Number of lanes, N                          2
Density, D                                  4.7            pc/mi/ln
Level of service, LOS                       A

  Overall results are not computed when free-flow speed is less than 55 mph.
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                    HCS+: Basic Freeway Segments Release 5.21

Phone:                                      Fax:
E-mail:

_________________________Operational Analysis__________________________________

Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         4/2/2008 12:59:54 PM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Southbound
From/To:                Sunflower Road to Edgerton Road
Jurisdiction:
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                   505            veh/h
Peak-hour factor, PHF                       0.90
Peak 15-min volume, v15                     140            v
Trucks and buses                            19             %
Recreational vehicles                       0              %
Terrain type:                               Level
    Grade                                   0.00           %
    Segment length                          0.00           mi
Trucks and buses PCE, ET                    1.5
Recreational vehicle PCE, ER                1.2
Heavy vehicle adjustment, fHV               0.913
Driver population factor, fp                1.00
Flow rate, vp                               307            pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                  12.0           ft
Right-shoulder lateral clearance            6.0            ft
Interchange density                         0.50           interchange/mi
Number of lanes, N                          2
Free-flow speed:                            Measured
     FFS or BFFS                            70.0           mi/h
Lane width adjustment, fLW                  0.0            mi/h
Lateral clearance adjustment, fLC           0.0            mi/h
Interchange density adjustment, fID         0.0            mi/h
Number of lanes adjustment, fN              0.0            mi/h
Free-flow speed, FFS                        70.0           mi/h
                                            Rural Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                               307            pc/h/ln
Free-flow speed, FFS                        70.0           mi/h
Average passenger-car speed, S              70.0           mi/h
Number of lanes, N                          2
Density, D                                  4.4            pc/mi/ln
Level of service, LOS                       A

  Overall results are not computed when free-flow speed is less than 55 mph.
```

2010 Proposed Action - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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E-mail:

Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 12:59:54 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Edgerton Road to Sunflower Road
Jurisdiction:	
Analysis Year:	2010
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	695	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	193	v
Trucks and buses	20	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.909	
Driver population factor, fp	1.00	
Flow rate, vp	425	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	425	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	6.1	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 12:59:54 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Sunflower Road to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	780	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	217	v
Trucks and buses	19	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.913	
Driver population factor, fp	1.00	
Flow rate, vp	475	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	475	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	6.8	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

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_______Operational Analysis_______

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 12:59:54 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Gardner Road to US 56
Jurisdiction:	KDOT
Analysis Year:	2010
Description: NEPA Traffic Study	

_______Flow Inputs and Adjustments_______

Volume, V	1040	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	289	v
Trucks and buses	21	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.905	
Driver population factor, fp	1.00	
Flow rate, vp	638	pc/h/ln

_______Speed Inputs and Adjustments_______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______LOS and Performance Measures_______

Flow rate, vp	638	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	9.1	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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_______Operational Analysis_______

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 12:59:54 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	US 56 to 151st Street
Jurisdiction:	KDOT
Analysis Year:	2010
Description: NEPA Traffic Study	

_______Flow Inputs and Adjustments_______

Volume, V	1920	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	533	v
Trucks and buses	13	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.939	
Driver population factor, fp	1.00	
Flow rate, vp	1136	pc/h/ln

_______Speed Inputs and Adjustments_______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______LOS and Performance Measures_______

Flow rate, vp	1136	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	16.2	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Proposed Action - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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_____Operational Analysis_____

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 12:59:54 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	151Street to US 56
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	3170	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	881	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1840	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	1840	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	67.4	mi/h
Number of lanes, N	2	
Density, D	27.3	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

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_____Operational Analysis_____

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 12:59:54 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	US 56 to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	2160	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	600	v
Trucks and buses	13	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.939	
Driver population factor, fp	1.00	
Flow rate, vp	1278	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	1278	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	18.3	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

Level of service, LOS B

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 4/2/2008 12:59:54 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: Gardner Road to Sunflower Road
Jurisdiction: KDOT
Analysis Year: 2010
Description: NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	1630	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	453	v
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.948	
Driver population factor, fp	1.00	
Flow rate, vp	955	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	955	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	13.6	pc/mi/ln

Level of service, LOS B

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 4/2/2008 12:59:54 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: Sunflower Road to Edgerton Road
Jurisdiction:
Analysis Year: 2010
Description: NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	1380	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	383	v
Trucks and buses	13	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.939	
Driver population factor, fp	1.00	
Flow rate, vp	817	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	817	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	11.7	pc/mi/ln

2010 Proposed Action - AM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
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_________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data____________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1195           vph

_________________________________Off Ramp Data____________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0           mph
Volume on ramp                             15             vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1195        15                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                332         4                    v
Trucks and buses                       9           7                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.957       0.905
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1388        18                      pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1388   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1388          4800            No
      Fi   F
     v  = v - v            1370          4800            No
      FO   F   R
     v                     18            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1388          4600                   No
      12                                                                      !
________________Level of Service Determination (if not F)_____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =    9.0     pc/mi/ln
                                         R            12         D
Level of service for ramp-freeway junction areas of influence A

______________________________Speed Estimation_________________________________

Intermediate speed variable,                  D  = 0.430
                                               S
Space mean speed in ramp influence area,      S  = 58.0    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 58.0    mph
_______________________________________________________________________________
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Phone:                                   Fax:
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_________________________________Merge Analysis__________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data____________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1180           vph

__________________________________On Ramp Data____________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             280            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1180        280                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                328         78                   v
Trucks and buses                       9           1                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.957       0.985
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1370        316                     pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1370   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1686          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1370          4400                   No
      12                                                                      !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   13.5    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation_________________________________

Intermediate speed variable,                  M  = 0.286
                                               S
Space mean speed in ramp influence area,      S  = 62.0    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 62.0    mph
_______________________________________________________________________________
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2010 Proposed Action - AM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                      Fax:
E-mail:

_________________________________Diverge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1460           vph

_________________________________Off Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              90             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1460        90                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                406         25                   v
Trucks and buses                       8           4                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.962       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1687        106                  pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1687   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1687          4800            No
      Fi   F
     v  = v - v            1581          4800            No
      FO   F   R
     v                     106           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual       Max Desirable          Violation?
     v                1687         4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density,            D = 4.252 + 0.0086 v  - 0.009  L   =   11.6    pc/mi/ln
                        R                12         D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation_________________________________

Intermediate speed variable,                 D  = 0.438
                                              S
Space mean speed in ramp influence area,     S  = 57.7    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.7    mph
_______________________________________________________________________________
```

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                      Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1370           vph

__________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              700            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1370        700                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                381         194                  v
Trucks and buses                       8           12                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.962       0.847
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1583        918                  pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1583   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2501          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area_____________________
                      Actual       Max Desirable          Violation?
     v                1583         4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   19.5    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation_________________________________

Intermediate speed variable,                 M  = 0.313
                                              S
Space mean speed in ramp influence area,     S  = 61.2    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.2    mph
_______________________________________________________________________________
```

2010 Proposed Action - AM Peak Hour - HCS Freeway Ramps

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                      HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis_______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         2070          vph

_________________________________Off Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            240           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       2070        240                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               575         67                    v
Trucks and buses                      10          7                     %
Recreational vehicles                 0           0                     %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %             %
     Length                           0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.952       0.905
Driver population factor, fP          1.00        1.00
Flow rate, vp                         2415        295                   pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2415   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                2415          4800            No
      Fi   F
     v  = v - v            2120          4800            No
      FO   F   R
     v                     295           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                2415          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L  =   17.8    pc/mi/ln
                                         R           12      D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation_________________________________

Intermediate speed variable,                 D  = 0.455
                                              S
Space mean speed in ramp influence area,     S  = 57.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.3    mph
_______________________________________________________________________________
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                      HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis_________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         3250          vph

__________________________________On Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            130           vph
Length of first accel/decel lane          1000          ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       3250        130                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               903         36                    v
Trucks and buses                      10          2                     %
Recreational vehicles                 0           0                     %
Terrain type:                         Level       Rolling
     Grade                                    %           %             %
     Length                                   mi          mi            mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.952       0.971
Driver population factor, fP          1.00        1.00
Flow rate, vp                         3792        149                   pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  3792   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     3941          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                3792          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L  =   29.9    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  D

______________________________Speed Estimation_________________________________

Intermediate speed variable,                 M  = 0.452
                                              S
Space mean speed in ramp influence area,     S  = 57.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.4    mph
_______________________________________________________________________________
```

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Phone:                                    Fax:
E-mail:

________________________________Merge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1830          vph

_________________________________On Ramp Data_______________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            1420          vph
Length of first accel/decel lane          500           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions_______________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1830        1420                 vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               508         394                  v
Trucks and buses                      10          2                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                                    %           %          %
     Length                                   mi          mi         mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.952       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2135        1625                    pcph

_________________________Estimation of V12 Merge Areas_______________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2135   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     3760          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area___________________
                      Actual        Max Desirable          Violation?
     v                2135          4400                   No
      12                                                                    !
_________________Level of Service Determination (if not F)__________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   30.9    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  D

_____________________________Speed Estimation_______________________________

Intermediate speed variable,              M  = 0.453
                                           S
Space mean speed in ramp influence area,  S  = 57.3    mph
                                           R
Space mean speed in outer lanes,          S  =  N/A    mph
                                           0
Space mean speed for all vehicles,        S  = 57.3    mph
____________________________________________________________________________
```

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E-mail:

________________________________Diverge Analysis____________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               8 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1570          vph

________________________________Off Ramp Data_______________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   45.0          mph
Volume on ramp                            970           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions_______________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1570        970                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               436         269                  v
Trucks and buses                      11          3                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %          %
     Length                           0.00    mi  0.00    mi         mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.948       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1840        1126                    pcph

_________________________Estimation of V12 Diverge Areas_____________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1840   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v  = v                1840          4800            No
      Fi   F
     v  = v - v            714           4800            No
      FO   F   R
     v                     1126          2100            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable          Violation?
     v                1840          4600                   No
      12                                                                    !
_________________Level of Service Determination (if not F)__________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   12.9    pc/mi/ln
                                          R           12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation_______________________________

Intermediate speed variable,              D  = 0.399
                                           S
Space mean speed in ramp influence area,  S  = 58.8    mph
                                           R
Space mean speed in outer lanes,          S  =  N/A    mph
                                           0
Space mean speed for all vehicles,        S  = 58.8    mph
____________________________________________________________________________
```

2010 Proposed Action - AM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               9 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         600            vph

_________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0           mph
Volume on ramp                            70             vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       600         70                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               167         19                   v
Trucks and buses                      11          16                   %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.948       0.806
Driver population factor, fP           1.00        1.00
Flow rate, vp                          703         96                     pcph

________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  703    pc/h
                   12   F   FM

______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     799           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                703           4400                   No
      12                                                                     !
________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   6.6     pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  A

____________________________Speed Estimation_________________________________

Intermediate speed variable,                M  = 0.274
                                             S
Space mean speed in ramp influence area,    S  = 62.3    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 62.3    mph
_____________________________________________________________________________
```

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         670            vph

________________________________Off Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0           mph
Volume on ramp                            190            vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       670         190                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               186         53                   v
Trucks and buses                      23          0                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %           %
     Length                           0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.897       1.000
Driver population factor, fP           1.00        1.00
Flow rate, vp                          830         211                    pcph

________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  830    pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v  = v                830           4800            No
      Fi   F
     v  = v - v            619           4800            No
      FO   F   R
     v                     211           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

_____________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                830           4600                   No
      12                                                                     !
________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   4.2     pc/mi/ln
                       R                 12          D
Level of service for ramp-freeway junction areas of influence A

____________________________Speed Estimation_________________________________

Intermediate speed variable,                D  = 0.447
                                             S
Space mean speed in ramp influence area,    S  = 57.5    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.5    mph
_____________________________________________________________________________
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2010 Proposed Action - AM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          4/2/2008 12:59:54 PM
Analysis time period:    AM
Freeway/Dir of Travel:   I-35 Southbound
Junction:                11 Gardner Entr
Jurisdiction:            KDOT
Analysis Year:           2010
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         480           vph

__________________________________On Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            60            vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       480         60                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               133         17                   v
Trucks and buses                      23          7                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                                    %           %            %
     Length                                   mi          mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.897       0.905
Driver population factor, fP          1.00        1.00
Flow rate, vp                         595         74                         pcph

_________________________Estimation of V12 Merge Areas___________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  595    pc/h
                   12   F   FM

______________________________Capacity Checks_______________________________

                             Actual        Maximum         LOS F?
     v                       669           4800            No
      FO
     v     v                 0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?            No
      3 or  av34
Is   v     v       > 1.5 v  /2             No
      3 or  av34          12
If yes, v    =                             (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                        Actual        Max Desirable          Violation?
     v                  595           4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   5.6     pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                 M  = 0.273
                                              S
Space mean speed in ramp influence area,     S  = 62.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.4    mph
_______________________________________________________________________________
```

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Phone:                                    Fax:
E-mail:

________________________________Diverge Analysis_________________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          4/2/2008 12:59:54 PM
Analysis time period:    AM
Freeway/Dir of Travel:   I-35 Southbound
Junction:                12 Sunflower Exit
Jurisdiction:            KDOT
Analysis Year:           2010
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         540           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            50            vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       540         50                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               150         14                   v
Trucks and buses                      18          4                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %            %
     Length                           0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.917       0.943
Driver population factor, fP          1.00        1.00
Flow rate, vp                         654         59                         pcph

_________________________Estimation of V12 Diverge Areas_________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  654    pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_______________________________

                             Actual        Maximum         LOS F?
     v  = v                  654           4800            No
      Fi   F
     v  = v - v              595           4800            No
      FO   F   R
     v                       59            2000            No
      R
     v     v                 0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?            No
      3 or  av34
Is   v     v       > 1.5 v  /2             No
      3 or  av34          12
If yes, v    =                             (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                        Actual        Max Desirable          Violation?
     v                  654           4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density,                D = 4.252 + 0.0086 v  - 0.009  L   =   2.7     pc/mi/ln
                                           R           12          D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                 D  = 0.433
                                              S
Space mean speed in ramp influence area,     S  = 57.9    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.9    mph
_______________________________________________________________________________
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2010 Proposed Action - AM Peak Hour - HCS Freeway Ramps

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             HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis_______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           490           vph

__________________________________On Ramp Data________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              15            vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         490         15                    vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 136         4                     v
Trucks and buses                        18          0                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                                      %           %           %
     Length                                     mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.917       1.000
Driver population factor, fP            1.00        1.00
Flow rate, vp                           593         17                    pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  593    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     610           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                593           4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   5.2     pc/mi/ln
          R                  R          12           A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                  M  = 0.272
                                               S
Space mean speed in ramp influence area,      S  = 62.4    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 62.4    mph
_______________________________________________________________________________
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2010 Proposed Action - PM Peak Hour - HCS Freeway Ramps

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Phone:                                     Fax:
E-mail:

_________________________________Diverge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           695           vph

_________________________________Off Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              15            vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        695         15                    vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                193         4                     v
Trucks and buses                       20          0                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %             %
     Length                            0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.909       1.000
Driver population factor, fP           1.00        1.00
Flow rate, vp                          849         17                    pcph

_________________________Estimation of V12 Diverge Areas______________________

                 L  =            (Equation 25-8 or 25-9)
                  EQ
                 P  =    1.000   Using Equation  0
                  FD
                 v  = v  + (v - v ) P  =  849    pc/h
                  12   R     F   R   FD

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                849           4800            No
      Fi   F
     v  = v - v            832           4800            No
      FO   F   R
     v                     17            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34        12
If yes, v    =                           (Equation 25-18)
         12A

_____________________Flow Entering Diverge Influence Area____________________
                      Actual       Max Desirable          Violation?
     v                849          4600                   No
      12                                                                   !
________________Level of Service Determination (if not F)___________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   4.4     pc/mi/ln
                                         R           12        D
Level of service for ramp-freeway junction areas of influence A

____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.430
                                              S
Space mean speed in ramp influence area,     S  = 58.0    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 58.0    mph
______________________________________________________________________________
```

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Phone:                                     Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           680           vph

__________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              100           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        680         100                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                189         28                    v
Trucks and buses                       20          4                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                                     %           %             %
     Length                                    mi          mi            mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.909       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          831         118                   pcph

_________________________Estimation of V12 Merge Areas________________________

                 L  =            (Equation 25-2 or 25-3)
                  EQ
                 P  =    1.000   Using Equation  0
                  FM
                 v  = v  (P  ) =  831    pc/h
                  12   F   FM

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     949           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34        12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area____________________
                      Actual       Max Desirable          Violation?
     v                831          4400                   No
      12                                                                   !
________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   7.8     pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  A

____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.275
                                              S
Space mean speed in ramp influence area,     S  = 62.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.3    mph
______________________________________________________________________________
```

2010 Proposed Action - PM Peak Hour - HCS Freeway Ramps

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                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         780           vph

________________________________Off Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            60            vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

___________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        780         60                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                217         17                   v
Trucks and buses                       19          12                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.913       0.847
Driver population factor, fP           1.00        1.00
Flow rate, vp                          949         79                   pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  949    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v  = v                949           4800            No
      Fi   F
     v  = v - v            870           4800            No
      FO   F   R
     v                     79            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                949           4600                  No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   5.2     pc/mi/ln
                       R                 12          D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                 D  = 0.435
                                              S
Space mean speed in ramp influence area,     S  = 57.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.8    mph
______________________________________________________________________________
```

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Phone:                                   Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         720           vph

_________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            320           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

___________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        720         320                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                200         89                   v
Trucks and buses                       19          0                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.913       1.000
Driver population factor, fP           1.00        1.00
Flow rate, vp                          876         356                  pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  876    pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v                     1232          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                876           4400                  No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   9.9     pc/mi/ln
          R                  R           12            A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                 M  = 0.278
                                              S
Space mean speed in ramp influence area,     S  = 62.2    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.2    mph
______________________________________________________________________________
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Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1040          vph

_________________________________Off Ramp Data___________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            120           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                  Freeway     Ramp       Adjacent
                                                            Ramp
Volume, V (vph)                      1040        120                  vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              289         33                   v
Trucks and buses                     21          9                    %
Recreational vehicles                0           0                    %
Terrain type:                        Level       Rolling
     Grade                           0.00    %   0.00    %            %
     Length                          0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
Heavy vehicle adjustment, fHV          0.905      0.881
Driver population factor, fP           1.00       1.00
Flow rate, vp                          1277       151                      pcph

_________________________Estimation of V12 Diverge Areas_________________________

                 L  =             (Equation 25-8 or 25-9)
                  EQ
                 P  =    1.000   Using Equation  0
                  FD
                 v  = v  + (v - v ) P  =  1277   pc/h
                  12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                          Actual        Maximum         LOS F?
     v  = v               1277          4800            No
      Fi   F
     v  = v - v           1126          4800            No
      FO   F   R
     v                    151           2000            No
      R
     v     v              0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?          No
      3 or  av34
Is   v     v      > 1.5 v  /2           No
      3 or  av34         12
If yes, v   =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                     Actual        Max Desirable          Violation?
     v               1277          4600                   No
      12                                                                       !
________________Level of Service Determination (if not F)_____________________

Density,          D = 4.252 + 0.0086 v  - 0.009  L   =   8.0     pc/mi/ln
                   R                  12          D
Level of service for ramp-freeway junction areas of influence A

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.442
                                              S
Space mean speed in ramp influence area,     S  = 57.6    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.6    mph
_______________________________________________________________________________
```

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Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1900          vph

__________________________________On Ramp Data___________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            20            vph
Length of first accel/decel lane          1000          ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                  Freeway     Ramp       Adjacent
                                                            Ramp
Volume, V (vph)                      1900        20                   vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              528         6                    v
Trucks and buses                     21          3                    %
Recreational vehicles                0           0                    %
Terrain type:                        Level       Rolling
     Grade                                   %           %            %
     Length                                  mi          mi           mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
Heavy vehicle adjustment, fHV          0.905      0.957
Driver population factor, fP           1.00       1.00
Flow rate, vp                          2333       23                       pcph

_________________________Estimation of V12 Merge Areas__________________________

                 L  =             (Equation 25-2 or 25-3)
                  EQ
                 P  =    1.000   Using Equation  0
                  FM
                 v  = v  (P  ) =  2333   pc/h
                  12   F   FM

_______________________________Capacity Checks__________________________________

                          Actual        Maximum         LOS F?
     v                    2356          4800            No
      FO
     v     v              0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?          No
      3 or  av34
Is   v     v      > 1.5 v  /2           No
      3 or  av34         12
If yes, v   =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                     Actual        Max Desirable          Violation?
     v               2333          4400                   No
      12                                                                       !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   17.6    pc/mi/ln
          R                   R            12           A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.292
                                              S
Space mean speed in ramp influence area,     S  = 61.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.8    mph
_______________________________________________________________________________
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2010 Proposed Action - PM Peak Hour - HCS Freeway Ramps

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Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         920           vph

__________________________________On Ramp Data_______________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            980           vph
Length of first accel/decel lane          500           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                   Freeway    Ramp       Adjacent
                                                            Ramp
Volume, V (vph)                       920        980                  vph
Peak-hour factor, PHF                 0.90       0.90
Peak 15-min volume, v15               256        272                  v
Trucks and buses                      21         3                    %
Recreational vehicles                 0          0                    %
Terrain type:                         Level      Rolling
     Grade                                   %          %          %
     Length                                 mi         mi         mi
Trucks and buses PCE, ET              1.5*       2.5
Recreational vehicle PCE, ER          1.2*       2.0
```

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Heavy vehicle adjustment, fHV          0.905       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1130        1138                    pcph

_________________________Estimation of V12 Merge Areas_______________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1130   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     2268          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                1130          4400                  No
      12                                                                   !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   19.5    pc/mi/ln
          R                  R           12           A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation________________________________

Intermediate speed variable,                 M  = 0.324
                                              S
Space mean speed in ramp influence area,     S  = 60.9    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 60.9    mph
_____________________________________________________________________________
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Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis____________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               8 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         3170          vph

_________________________________Off Ramp Data_______________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   45.0          mph
Volume on ramp                            1320          vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                   Freeway    Ramp       Adjacent
                                                            Ramp
Volume, V (vph)                       3170       1320                 vph
Peak-hour factor, PHF                 0.90       0.90
Peak 15-min volume, v15               881        367                  v
Trucks and buses                      9          2                    %
Recreational vehicles                 0          0                    %
Terrain type:                         Level      Rolling
     Grade                            0.00   %   0.00   %          %
     Length                           0.00   mi  0.00   mi         mi
Trucks and buses PCE, ET              1.5*       2.5
Recreational vehicle PCE, ER          1.2*       2.0
```

```
Heavy vehicle adjustment, fHV          0.957       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3681        1511                    pcph

_________________________Estimation of V12 Diverge Areas_____________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  3681   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v  = v                3681          4800            No
      Fi   F
     v  = v - v            2170          4800            No
      FO   F  R
     v                     1511          2100            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

_____________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                3681          4600                  No
      12                                                                   !
_________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   28.7    pc/mi/ln
                                         R           12           D
Level of service for ramp-freeway junction areas of influence D

_____________________________Speed Estimation________________________________

Intermediate speed variable,                 D  = 0.434
                                              S
Space mean speed in ramp influence area,     S  = 57.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.8    mph
_____________________________________________________________________________
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2010 Proposed Action - PM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis_________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               9 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1850          vph

__________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              310           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1850        310                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 514         86                   v
Trucks and buses                        9           4                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %           %
     Length                                     mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.957       0.943
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2148        365                  pcph

________________________Estimation of V12 Merge Areas__________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2148   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum        LOS F?
     v                     2513          4800           No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                2148          4400                  No
      12                                                                     !
_________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   19.9    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation_________________________________

Intermediate speed variable,               M  = 0.313
                                            S
Space mean speed in ramp influence area,   S  = 61.2    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 61.2    mph
_______________________________________________________________________________
```

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________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2160          vph

_________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              630           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2160        630                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 600         175                  v
Trucks and buses                        13          17                   %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %           %
     Length                             0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.939       0.797
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2556        878                  pcph

________________________Estimation of V12 Diverge Areas________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2556   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum        LOS F?
     v  = v                2556          4800           No
      Fi   F
     v  = v - v            1678          4800           No
      FO   F   R
     v                     878           2000           No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable         Violation?
     v                2556          4600                  No
      12                                                                     !
_________________Level of Service Determination (if not F)___________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   19.0    pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation_________________________________

Intermediate speed variable,               D  = 0.507
                                            S
Space mean speed in ramp influence area,   S  = 55.8    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 55.8    mph
_______________________________________________________________________________
```

2010 Proposed Action - PM Peak Hour - HCS Freeway Ramps

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Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                         Merge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0          mph
Volume on freeway                        1530          vph

__________________________________On Ramp Data_________________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-flow speed on ramp                  35.0          mph
Volume on ramp                           100           vph
Length of first accel/decel lane         800           ft
Length of second accel/decel lane                      ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                No
Volume on adjacent Ramp                                vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                              ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                  Freeway     Ramp        Adjacent
                                                             Ramp
Volume, V (vph)                      1530        100                   vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              425         28                    v
Trucks and buses                     13          7                     %
Recreational vehicles                0           0                     %
Terrain type:                        Level       Rolling
     Grade                                   %           %            %
     Length                                 mi          mi           mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.939       0.905
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1811        123                       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1811   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1934          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?          No
      3 or  av34
Is   v     v        > 1.5 v  /2           No
      3 or  av34           12
If yes, v    =                            (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1811          4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   15.5    pc/mi/ln
                               R                  12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                  M  = 0.292
                                               S
Space mean speed in ramp influence area,      S  = 61.8    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 61.8    mph
_______________________________________________________________________________
```

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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                         Diverge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0          mph
Volume on freeway                        1630          vph

_________________________________Off Ramp Data_________________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-Flow speed on ramp                  35.0          mph
Volume on ramp                           280           vph
Length of first accel/decel lane         800           ft
Length of second accel/decel lane                      ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                No
Volume on adjacent ramp                                vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                              ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                  Freeway     Ramp        Adjacent
                                                             Ramp
Volume, V (vph)                      1630        280                   vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              453         78                    v
Trucks and buses                     11          1                     %
Recreational vehicles                0           0                     %
Terrain type:                        Level       Rolling
     Grade                           0.00    %   0.00    %            %
     Length                          0.00   mi   0.00   mi           mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.948       0.985
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1911        316                       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1911   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1911          4800            No
      Fi   F
     v  = v - v            1595          4800            No
      FO   F   R
     v                     316           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?          No
      3 or  av34
Is   v     v        > 1.5 v  /2           No
      3 or  av34           12
If yes, v    =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1911          4600                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   13.5    pc/mi/ln
                                         R           12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                  D  = 0.456
                                               S
Space mean speed in ramp influence area,      S  = 57.2    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 57.2    mph
_______________________________________________________________________________
```

2010 Proposed Action - PM Peak Hour - HCS Freeway Ramps

```
                 HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                     Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 12:59:54 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1350           vph

__________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              30             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1350        30                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 375         8                    v
Trucks and buses                        11          7                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %           %
     Length                                     mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.948       0.905
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1583        37                   pcph

________________________Estimation of V12 Merge Areas__________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1583   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1620          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1583          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   13.1    pc/mi/ln
          R                   R           12           A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.285
                                              S
Space mean speed in ramp influence area,     S  = 62.0    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.0    mph
_______________________________________________________________________________
```

2015 Gardner No Action - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/24/2008 10:31:41 AM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Edgerton Road to Sunflower Road
Jurisdiction:	
Analysis Year:	2015
Description:	NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	1295	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	360	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	755	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	755	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	10.8	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/24/2008 10:31:41 AM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Sunflower Road to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2015
Description:	NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	1700	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	472	v
Trucks and buses	8	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.962	
Driver population factor, fp	1.00	
Flow rate, vp	982	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	982	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	14.0	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2015 Gardner No Action - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

____Operational Analysis____

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/24/2008 10:31:41 AM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: Gardner Road to US 56
Jurisdiction: KDOT
Analysis Year: 2015
Description: NEPA Traffic Study

____Flow Inputs and Adjustments____

Volume, V	2270	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	631	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1299	pc/h/ln

____Speed Inputs and Adjustments____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

____LOS and Performance Measures____

Flow rate, vp	1299	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	18.6	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

____Operational Analysis____

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/24/2008 10:31:41 AM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: US 56 to 151st Street
Jurisdiction: KDOT
Analysis Year: 2015
Description: NEPA Traffic Study

____Flow Inputs and Adjustments____

Volume, V	3770	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1047	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	2136	pc/h/ln

____Speed Inputs and Adjustments____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

____LOS and Performance Measures____

Flow rate, vp	2136	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	61.8	mi/h
Number of lanes, N	2	
Density, D	34.5	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

2015 Gardner No Action - AM Peak Hour - HCS Freeway Mainline

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Phone:                                      Fax:
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_________________________Operational Analysis__________________________________

Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         3/24/2008 10:31:41 AM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Southbound
From/To:                151Street to US 56
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                   1710           veh/h
Peak-hour factor, PHF                       0.90
Peak 15-min volume, v15                     475            v
Trucks and buses                            9              %
Recreational vehicles                       0              %
Terrain type:                               Level
    Grade                                   0.00           %
    Segment length                          0.00           mi
Trucks and buses PCE, ET                    1.5
Recreational vehicle PCE, ER                1.2
Heavy vehicle adjustment, fHV               0.957
Driver population factor, fp                1.00
Flow rate, vp                               993            pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                  12.0           ft
Right-shoulder lateral clearance            6.0            ft
Interchange density                         0.50           interchange/mi
Number of lanes, N                          2
Free-flow speed:                            Measured
     FFS or BFFS                            70.0           mi/h
Lane width adjustment, fLW                  0.0            mi/h
Lateral clearance adjustment, fLC           0.0            mi/h
Interchange density adjustment, fID         0.0            mi/h
Number of lanes adjustment, fN              0.0            mi/h
Free-flow speed, FFS                        70.0           mi/h
                                            Rural Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                               993            pc/h/ln
Free-flow speed, FFS                        70.0           mi/h
Average passenger-car speed, S              70.0           mi/h
Number of lanes, N                          2
Density, D                                  14.2           pc/mi/ln
Level of service, LOS                       B

  Overall results are not computed when free-flow speed is less than 55 mph.
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                    HCS+: Basic Freeway Segments Release 5.21


Phone:                                      Fax:
E-mail:

_________________________Operational Analysis__________________________________

Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         3/24/2008 10:31:41 AM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Southbound
From/To:                US 56 to Gardner Road
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                   670            veh/h
Peak-hour factor, PHF                       0.90
Peak 15-min volume, v15                     186            v
Trucks and buses                            18             %
Recreational vehicles                       0              %
Terrain type:                               Level
    Grade                                   0.00           %
    Segment length                          0.00           mi
Trucks and buses PCE, ET                    1.5
Recreational vehicle PCE, ER                1.2
Heavy vehicle adjustment, fHV               0.917
Driver population factor, fp                1.00
Flow rate, vp                               406            pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                  12.0           ft
Right-shoulder lateral clearance            6.0            ft
Interchange density                         0.50           interchange/mi
Number of lanes, N                          2
Free-flow speed:                            Measured
     FFS or BFFS                            70.0           mi/h
Lane width adjustment, fLW                  0.0            mi/h
Lateral clearance adjustment, fLC           0.0            mi/h
Interchange density adjustment, fID         0.0            mi/h
Number of lanes adjustment, fN              0.0            mi/h
Free-flow speed, FFS                        70.0           mi/h
                                            Rural Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                               406            pc/h/ln
Free-flow speed, FFS                        70.0           mi/h
Average passenger-car speed, S              70.0           mi/h
Number of lanes, N                          2
Density, D                                  5.8            pc/mi/ln
Level of service, LOS                       A

  Overall results are not computed when free-flow speed is less than 55 mph.
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2015 Gardner No Action - AM Peak Hour - HCS Freeway Mainline

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                    HCS+: Basic Freeway Segments Release 5.21



Phone:                                      Fax:
E-mail:

_________________________Operational Analysis__________________________________

Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         3/24/2008 10:31:41 AM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Southbound
From/To:                Gardner Road to Sunflower Road
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                   620           veh/h
Peak-hour factor, PHF                       0.90
Peak 15-min volume, v15                     172           v
Trucks and buses                            18            %
Recreational vehicles                       0             %
Terrain type:                               Level
    Grade                                   0.00          %
    Segment length                          0.00          mi
Trucks and buses PCE, ET                    1.5
Recreational vehicle PCE, ER                1.2
Heavy vehicle adjustment, fHV               0.917
Driver population factor, fp                1.00
Flow rate, vp                               375           pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                  12.0          ft
Right-shoulder lateral clearance            6.0           ft
Interchange density                         0.50          interchange/mi
Number of lanes, N                          2
Free-flow speed:                            Measured
     FFS or BFFS                            70.0          mi/h
Lane width adjustment, fLW                  0.0           mi/h
Lateral clearance adjustment, fLC           0.0           mi/h
Interchange density adjustment, fID         0.0           mi/h
Number of lanes adjustment, fN              0.0           mi/h
Free-flow speed, FFS                        70.0          mi/h
                                            Rural Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                               375           pc/h/ln
Free-flow speed, FFS                        70.0          mi/h
Average passenger-car speed, S              70.0          mi/h
Number of lanes, N                          2
Density, D                                  5.4           pc/mi/ln
Level of service, LOS                       A

  Overall results are not computed when free-flow speed is less than 55 mph.
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Phone:                                      Fax:
E-mail:

_________________________Operational Analysis__________________________________

Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         3/24/2008 10:31:41 AM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Southbound
From/To:                Sunflower Road to Edgerton Road
Jurisdiction:
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                   555           veh/h
Peak-hour factor, PHF                       0.90
Peak 15-min volume, v15                     154           v
Trucks and buses                            18            %
Recreational vehicles                       0             %
Terrain type:                               Level
    Grade                                   0.00          %
    Segment length                          0.00          mi
Trucks and buses PCE, ET                    1.5
Recreational vehicle PCE, ER                1.2
Heavy vehicle adjustment, fHV               0.917
Driver population factor, fp                1.00
Flow rate, vp                               336           pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                  12.0          ft
Right-shoulder lateral clearance            6.0           ft
Interchange density                         0.50          interchange/mi
Number of lanes, N                          2
Free-flow speed:                            Measured
     FFS or BFFS                            70.0          mi/h
Lane width adjustment, fLW                  0.0           mi/h
Lateral clearance adjustment, fLC           0.0           mi/h
Interchange density adjustment, fID         0.0           mi/h
Number of lanes adjustment, fN              0.0           mi/h
Free-flow speed, FFS                        70.0          mi/h
                                            Rural Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                               336           pc/h/ln
Free-flow speed, FFS                        70.0          mi/h
Average passenger-car speed, S              70.0          mi/h
Number of lanes, N                          2
Density, D                                  4.8           pc/mi/ln
Level of service, LOS                       A

  Overall results are not computed when free-flow speed is less than 55 mph.
```

2015 Gardner No Action - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_________________________Operational Analysis__________________________________

```
Analyst:                Tom Hiles
Agency or Company:      HDR Inc.
Date Performed:         3/27/2008 10:03:18 AM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Northbound
From/To:                Edgerton Road to Sunflower Road
Jurisdiction:
Analysis Year:          2015
Description:  NEPA Traffic Study
```

_________________________Flow Inputs and Adjustments___________________________

Volume, V	775	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	215	v
Trucks and buses	21	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.905	
Driver population factor, fp	1.00	
Flow rate, vp	476	pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_________________________LOS and Performance Measures__________________________

Flow rate, vp	476	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	6.8	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_________________________Operational Analysis__________________________________

```
Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         3/24/2008 10:31:41 AM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Northbound
From/To:                Sunflower Road to Gardner Road
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study
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_________________________Flow Inputs and Adjustments___________________________

Volume, V	910	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	253	v
Trucks and buses	18	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.917	
Driver population factor, fp	1.00	
Flow rate, vp	551	pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_________________________LOS and Performance Measures__________________________

Flow rate, vp	551	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	7.9	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

2015 Gardner No Action - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

___Operational Analysis___

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/24/2008 10:31:41 AM
Analysis Time Period: PM
Freeway/Direction: I-35 Northbound
From/To: Gardner Road to US 56
Jurisdiction: KDOT
Analysis Year: 2015
Description: NEPA Traffic Study

___Flow Inputs and Adjustments___

Volume, V	1130	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	314	v
Trucks and buses	16	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.926	
Driver population factor, fp	1.00	
Flow rate, vp	678	pc/h/ln

___Speed Inputs and Adjustments___

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

___LOS and Performance Measures___

Flow rate, vp	678	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	9.7	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

___Operational Analysis___

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/24/2008 10:31:41 AM
Analysis Time Period: PM
Freeway/Direction: I-35 Northbound
From/To: US 56 to 151st Street
Jurisdiction: KDOT
Analysis Year: 2015
Description: NEPA Traffic Study

___Flow Inputs and Adjustments___

Volume, V	2140	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	594	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1242	pc/h/ln

___Speed Inputs and Adjustments___

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

___LOS and Performance Measures___

Flow rate, vp	1242	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	17.7	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2015 Gardner No Action - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/24/2008 10:31:41 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	151Street to US 56
Jurisdiction:	KDOT
Analysis Year:	2015
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	3580	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	994	v
Trucks and buses	7	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.966	
Driver population factor, fp	1.00	
Flow rate, vp	2058	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	2058	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	63.7	mi/h
Number of lanes, N	2	
Density, D	32.3	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/24/2008 10:31:41 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	US 56 to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2015
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	2420	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	672	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1405	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	1405	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	20.1	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

2015 Gardner No Action - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_________________________Operational Analysis__________________________________

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/24/2008 10:31:41 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	Gardner Road to Sunflower Road
Jurisdiction:	KDOT
Analysis Year:	2015
Description:	NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V	1910	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	531	v
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.948	
Driver population factor, fp	1.00	
Flow rate, vp	1119	pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_________________________LOS and Performance Measures__________________________

Flow rate, vp	1119	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	16.0	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

_________________________Operational Analysis__________________________________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	3/27/2008 10:03:18 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	Sunflower Road to Edgerton Road
Jurisdiction:	
Analysis Year:	2015
Description:	NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V	1530	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	425	v
Trucks and buses	13	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.939	
Driver population factor, fp	1.00	
Flow rate, vp	905	pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_________________________LOS and Performance Measures__________________________

Flow rate, vp	905	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	12.9	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2015 Gardner No Action - AM Peak Hour - HCS Freeway Ramps

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                      HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                      Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:03:18 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1295           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              25             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1295        25                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 360         7                    v
Trucks and buses                        10          4                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.952       0.943
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1511        29                   pcph

_________________________Estimation of V12 Diverge Areas_________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1511   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks____________________________________

                           Actual        Maximum         LOS F?
     v  = v                1511          4800            No
      Fi   F
     v  = v - v            1482          4800            No
      FO   F   R
     v                     29            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_______________________
                      Actual        Max Desirable          Violation?
     v                1511          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_______________________

Density,           D = 4.252 + 0.0086 v  - 0.009  L   =   10.0+   pc/mi/ln
                                       R           12        D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation____________________________________

Intermediate speed variable,                 D  = 0.431
                                              S
Space mean speed in ramp influence area,     S  = 57.9    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.9    mph
_________________________________________________________________________________
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Phone:                                      Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:03:18 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1270           vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              430            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1270        430                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 353         119                  v
Trucks and buses                        10          1                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.952       0.985
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1482        485                  pcph

_________________________Estimation of V12 Merge Areas___________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1482   pc/h
                   12   F   FM

______________________________Capacity Checks____________________________________

                           Actual        Maximum         LOS F?
     v                     1967          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area________________________
                      Actual        Max Desirable          Violation?
     v                1482          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   15.6    pc/mi/ln
                              R             12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation____________________________________

Intermediate speed variable,                 M  = 0.293
                                              S
Space mean speed in ramp influence area,     S  = 61.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.8    mph
_________________________________________________________________________________
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2015 Gardner No Action - AM Peak Hour - HCS Freeway Ramps

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                HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                         Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1700          vph

_________________________________Off Ramp Data___________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            110           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1700        110                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               472         31                   v
Trucks and buses                      8           2                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %            %
     Length                           0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.962       0.971
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1964        126                  pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1964   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                1964          4800            No
      Fi   F
     v  = v - v            1838          4800            No
      FO   F   R
     v                     126           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1964          4600                   No
      12                                                                    !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   13.9    pc/mi/ln
                       R                  12           D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.439
                                              S
Space mean speed in ramp influence area,     S  = 57.7    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.7    mph
________________________________________________________________________________
```

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                HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                         Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1590          vph

__________________________________On Ramp Data___________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            680           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1590        680                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               442         189                  v
Trucks and buses                      8           2                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                                    %           %            %
     Length                                   mi          mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.962       0.971
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1837        778                  pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1837   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     2615          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1837          4400                   No
      12                                                                    !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   20.5    pc/mi/ln
          R                 R            12            A
Level of service for ramp-freeway junction areas of influence  C

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.318
                                              S
Space mean speed in ramp influence area,     S  = 61.1    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.1    mph
________________________________________________________________________________
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2015 Gardner No Action - AM Peak Hour - HCS Freeway Ramps

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                  HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                  Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         2270          vph

_________________________________Off Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            270           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        2270        270                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                631         75                   v
Trucks and buses                       6           7                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
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Heavy vehicle adjustment, fHV          0.971       0.905
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2598        332                     pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2598   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                2598          4800            No
      Fi   F
     v  = v - v            2266          4800            No
      FO   F   R
     v                     332           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2598          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   19.4    pc/mi/ln
                        R                  12         D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.458
                                              S
Space mean speed in ramp influence area,     S  = 57.2    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.2    mph
________________________________________________________________________________
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Phone:                                  Fax:
E-mail:

_________________________________Merge Analysis_________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         3630          vph

__________________________________On Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            140           vph
Length of first accel/decel lane          1000          ft
Length of second accel/decel lane                       ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        3630        140                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                1008        39                   v
Trucks and buses                       6           2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

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Heavy vehicle adjustment, fHV          0.971       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          4154        160                     pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  4154   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     4314          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                4154          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   32.8    pc/mi/ln
          R                R           12           A
Level of service for ramp-freeway junction areas of influence  D

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.542
                                              S
Space mean speed in ramp influence area,     S  = 54.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 54.8    mph
________________________________________________________________________________
```

2015 Gardner No Action - AM Peak Hour - HCS Freeway Ramps

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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         2000          vph

__________________________________On Ramp Data___________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            1630          vph
Length of first accel/decel lane          500           ft
Length of second accel/decel lane                       ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                  Freeway     Ramp        Adjacent
                                                             Ramp
Volume, V (vph)                      2000        1630                 vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              556         453                  v
Trucks and buses                     6           2                    %
Recreational vehicles                0           0                    %
Terrain type:                        Level       Rolling
     Grade                                   %           %            %
     Length                                  mi          mi           mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
Heavy vehicle adjustment, fHV        0.971       0.971
Driver population factor, fP         1.00        1.00
Flow rate, vp                        2289        1865                 pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2289   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     4154          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v         > 2700 pc/h?        No
      3 or  av34
Is   v     v         > 1.5 v  /2         No
      3 or  av34            12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2289          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   33.9    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  D

______________________________Speed Estimation__________________________________

Intermediate speed variable,               M  = 0.534
                                            S
Space mean speed in ramp influence area,   S  = 55.0    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 55.0    mph
________________________________________________________________________________
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Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               8 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1710          vph

_________________________________Off Ramp Data___________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   45.0          mph
Volume on ramp                            1120          vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                  Freeway     Ramp        Adjacent
                                                             Ramp
Volume, V (vph)                      1710        1120                 vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              475         311                  v
Trucks and buses                     9           3                    %
Recreational vehicles                0           0                    %
Terrain type:                        Level       Rolling
     Grade                           0.00    %   0.00    %            %
     Length                          0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
Heavy vehicle adjustment, fHV        0.957       0.957
Driver population factor, fP         1.00        1.00
Flow rate, vp                        1986        1300                 pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1986   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1986          4800            No
      Fi   F
     v  = v - v            686           4800            No
      FO   F   R
     v                     1300          2100            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v         > 2700 pc/h?        No
      3 or  av34
Is   v     v         > 1.5 v  /2         No
      3 or  av34            12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1986          4600                   No
      12                                                                     !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   14.1    pc/mi/ln
                                          R           12           D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation__________________________________

Intermediate speed variable,               D  = 0.415
                                            S
Space mean speed in ramp influence area,   S  = 58.4    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 58.4    mph
________________________________________________________________________________
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2015 Gardner No Action - AM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

________________________________Merge Analysis_________________________________

Analyst:                 Tom Hiles
Agency/Co.:              HDR Inc.
Date performed:          3/27/2008 10:03:18 AM
Analysis time period:    AM
Freeway/Dir of Travel:   I-35 Southbound
Junction:                9 US 56 Entr
Jurisdiction:            KDOT
Analysis Year:           2015
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          590            vph

_________________________________On Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             80             vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

___________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        590         80                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                164         22                   v
Trucks and buses                       9           14                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
    Grade                                     %           %           %
    Length                                    mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.957       0.826
Driver population factor, fP           1.00        1.00
Flow rate, vp                          685         108                  pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  685    pc/h
                   12   F   FM

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     793           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                685           4400                   No
      12                                                                      !
________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   6.6     pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  A

____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.274
                                              S
Space mean speed in ramp influence area,     S  = 62.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.3    mph
_______________________________________________________________________________
```

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Phone:                                    Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                 Tom Hiles
Agency/Co.:              HDR Inc.
Date performed:          3/27/2008 10:03:18 AM
Analysis time period:    AM
Freeway/Dir of Travel:   I-35 Southbound
Junction:                10 Gardner Exit
Jurisdiction:            KDOT
Analysis Year:           2015
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          670            vph

________________________________Off Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0           mph
Volume on ramp                             110            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

___________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        670         110                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                186         31                   v
Trucks and buses                       18          12                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
    Grade                              0.00   %    0.00   %           %
    Length                             0.00   mi   0.00   mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.917       0.847
Driver population factor, fP           1.00        1.00
Flow rate, vp                          811         144                  pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  811    pc/h
                   12   R      F   R   FD

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                811           4800            No
      Fi   F
     v  = v - v            667           4800            No
      FO   F   R
     v                     144           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable          Violation?
     v                811           4600                   No
      12                                                                      !
________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   4.0     pc/mi/ln
                       R                  12           D
Level of service for ramp-freeway junction areas of influence A

____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.441
                                              S
Space mean speed in ramp influence area,     S  = 57.7    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.7    mph
_______________________________________________________________________________
```

2015 Gardner No Action - AM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
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________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:03:18 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         560           vph

_________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            60            vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       560         60                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               156         17                   v
Trucks and buses                      18          3                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.917       0.957
Driver population factor, fP          1.00        1.00
Flow rate, vp                         678         70                   pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  678    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     748           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v          > 2700 pc/h?           No
      3 or  av34
Is   v     v          > 1.5 v  /2            No
      3 or  av34             12
If yes, v    =                               (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                678           4400                  No
      12                                                                      !
________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   6.3     pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  A

____________________________Speed Estimation_________________________________

Intermediate speed variable,               M  = 0.273
                                            S
Space mean speed in ramp influence area,   S  = 62.3    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 62.3    mph
______________________________________________________________________________
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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:03:18 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         620           vph

________________________________Off Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            90            vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       620         90                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               172         25                   v
Trucks and buses                      18          2                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %            %
     Length                           0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.917       0.971
Driver population factor, fP          1.00        1.00
Flow rate, vp                         751         103                  pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  751    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                751           4800            No
      Fi   F
     v  = v - v            648           4800            No
      FO   F   R
     v                     103           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v          > 2700 pc/h?           No
      3 or  av34
Is   v     v          > 1.5 v  /2            No
      3 or  av34             12
If yes, v    =                               (Equation 25-18)
         12A

_____________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                751           4600                  No
      12                                                                      !
________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   3.5     pc/mi/ln
                        R                  12           D
Level of service for ramp-freeway junction areas of influence A

____________________________Speed Estimation_________________________________

Intermediate speed variable,               D  = 0.437
                                            S
Space mean speed in ramp influence area,   S  = 57.8    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 57.8    mph
______________________________________________________________________________
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2015 Gardner No Action - AM Peak Hour - HCS Freeway Ramps

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               HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           530           vph

__________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              25            vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         530         25                    vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 147         7                     v
Trucks and buses                        18          0                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                                      %           %           %
     Length                                     mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.917       1.000
Driver population factor, fP            1.00        1.00
Flow rate, vp                           642         28                    pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  642    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     670           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                642           4400                  No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   5.7     pc/mi/ln
          R                  R           12            A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.273
                                              S
Space mean speed in ramp influence area,     S  = 62.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.4    mph
_______________________________________________________________________________
```

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Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:03:18 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           775            vph

_________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              25             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         775         25                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 215         7                    v
Trucks and buses                        21          0                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
    Grade                               0.00    %   0.00    %            %
    Length                              0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.905       1.000
Driver population factor, fP           1.00        1.00
Flow rate, vp                          952         28                       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  952    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                952           4800            No
      Fi   F
     v  = v - v            924           4800            No
      FO   F   R
     v                     28            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                952           4600                   No
      12                                                                       !
________________Level of Service Determination (if not F)______________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   5.2     pc/mi/ln
                          R                 12          D
Level of service for ramp-freeway junction areas of influence A

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.431
                                              S
Space mean speed in ramp influence area,     S  = 57.9    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.9    mph
_______________________________________________________________________________
```

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Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:03:18 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           750            vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              160            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         750         160                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 208         44                   v
Trucks and buses                        21          3                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
    Grade                                       %           %            %
    Length                                      mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.905       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          921         186                      pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  921    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1107          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                921           4400                   No
      12                                                                       !
________________Level of Service Determination (if not F)______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   9.0     pc/mi/ln
                              R            12            A
Level of service for ramp-freeway junction areas of influence  A

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.277
                                              S
Space mean speed in ramp influence area,     S  = 62.2    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.2    mph
_______________________________________________________________________________
```

2015 Gardner No Action - PM Peak Hour - HCS Freeway Ramps

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Phone:                                    Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:03:18 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          910           vph

________________________________Off Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0          mph
Volume on ramp                             70            vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

___________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        910         70                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                253         19                   v
Trucks and buses                       18          6                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
    Grade                              0.00    %   0.00    %            %
    Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.917       0.917
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1102        85                     pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1102   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1102          4800            No
      Fi   F
     v  = v - v            1017          4800            No
      FO   F   R
     v                     85            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable           Violation?
     v                1102          4600                    No
      12                                                                    !
_________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   6.5     pc/mi/ln
                          R                  12        D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.436
                                              S
Space mean speed in ramp influence area,     S  = 57.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.8    mph
_______________________________________________________________________________
```

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Phone:                                    Fax:
E-mail:

________________________________Merge Analysis_________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          840           vph

_________________________________On Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0          mph
Volume on ramp                             290           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

___________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        840         290                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                233         81                   v
Trucks and buses                       18          6                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
    Grade                                      %           %            %
    Length                                     mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.917       0.917
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1017        351                    pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1017   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1368          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable           Violation?
     v                1017          4400                    No
      12                                                                    !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   11.0    pc/mi/ln
                              R            12           A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.280
                                              S
Space mean speed in ramp influence area,     S  = 62.2    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.2    mph
_______________________________________________________________________________
```

2015 Gardner No Action - PM Peak Hour - HCS Freeway Ramps

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Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          3/24/2008 10:31:41 AM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                5 US-56 Exit
Jurisdiction:            KDOT
Analysis Year:           2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1130           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              130            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1130        130                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 314         36                   v
Trucks and buses                        16          8                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.926       0.893
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1356        162                      pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1356   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1356          4800            No
      Fi   F
     v  = v - v            1194          4800            No
      FO   F   R
     v                     162           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1356          4600                   No
      12                                                                      !
________________Level of Service Determination (if not F)______________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   8.7     pc/mi/ln
                                         R             12      D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,               D  = 0.443
                                            S
Space mean speed in ramp influence area,   S  = 57.6    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 57.6    mph
_______________________________________________________________________________
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Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          3/24/2008 10:31:41 AM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                6 US-56 Entr
Jurisdiction:            KDOT
Analysis Year:           2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           2120           vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              20             vph
Length of first accel/decel lane            1000           ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2120        20                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 589         6                    v
Trucks and buses                        16          3                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.926       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2544        23                       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2544   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2567          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2544          4400                   No
      12                                                                      !
________________Level of Service Determination (if not F)______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   19.2    pc/mi/ln
                              R            12             A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,               M  = 0.302
                                            S
Space mean speed in ramp influence area,   S  = 61.5    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 61.5    mph
_______________________________________________________________________________
```

2015 Gardner No Action - PM Peak Hour - HCS Freeway Ramps

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                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1000          vph

__________________________________On Ramp Data_______________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            1120          vph
Length of first accel/decel lane          500           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                   Freeway    Ramp       Adjacent
                                                            Ramp
Volume, V (vph)                       1000       1120                 vph
Peak-hour factor, PHF                 0.90       0.90
Peak 15-min volume, v15               278        311                  v
Trucks and buses                      16         3                    %
Recreational vehicles                 0          0                    %
Terrain type:                         Level      Rolling
     Grade                                   %          %          %
     Length                                  mi         mi         mi
Trucks and buses PCE, ET              1.5*       2.5
Recreational vehicle PCE, ER          1.2*       2.0
Heavy vehicle adjustment, fHV         0.926      0.957
Driver population factor, fP          1.00       1.00
Flow rate, vp                         1200       1300                 pcph

_________________________Estimation of V12 Merge Areas_______________________

                  L  =           (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1200   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                            Actual        Maximum         LOS F?
     v                      2500          4800            No
      FO
     v     v                0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?            No
      3 or  av34
Is   v     v      > 1.5 v  /2             No
      3 or  av34         12
If yes, v    =                            (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area___________________
                       Actual        Max Desirable         Violation?
     v                 1200          4400                  No
      12                                                                   !
_________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   21.2    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation________________________________

Intermediate speed variable,                M  = 0.334
                                             S
Space mean speed in ramp influence area,    S  = 60.7    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 60.7    mph
_____________________________________________________________________________
```

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                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis____________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               8 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         3580          vph

_________________________________Off Ramp Data_______________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   45.0          mph
Volume on ramp                            1520          vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                   Freeway    Ramp       Adjacent
                                                            Ramp
Volume, V (vph)                       3580       1520                 vph
Peak-hour factor, PHF                 0.90       0.90
Peak 15-min volume, v15               994        422                  v
Trucks and buses                      7          2                    %
Recreational vehicles                 0          0                    %
Terrain type:                         Level      Rolling
     Grade                            0.00   %   0.00   %          %
     Length                           0.00   mi  0.00   mi         mi
Trucks and buses PCE, ET              1.5*       2.5
Recreational vehicle PCE, ER          1.2*       2.0
Heavy vehicle adjustment, fHV         0.966      0.971
Driver population factor, fP          1.00       1.00
Flow rate, vp                         4117       1740                 pcph

_________________________Estimation of V12 Diverge Areas_____________________

                  L  =           (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  4117   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_______________________________

                            Actual        Maximum         LOS F?
     v  = v                 4117          4800            No
      Fi   F
     v  = v - v             2377          4800            No
      FO   F   R
     v                      1740          2100            No
      R
     v     v                0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?            No
      3 or  av34
Is   v     v      > 1.5 v  /2             No
      3 or  av34         12
If yes, v    =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area___________________
                       Actual        Max Desirable         Violation?
     v                 4117          4600                  No
      12                                                                   !
_________________Level of Service Determination (if not F)___________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   32.5    pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence D

_____________________________Speed Estimation________________________________

Intermediate speed variable,                D  = 0.455
                                             S
Space mean speed in ramp influence area,    S  = 57.3    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.3    mph
_____________________________________________________________________________
```

2015 Gardner No Action - PM Peak Hour - HCS Freeway Ramps

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                HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                          Fax:
E-mail:

_________________________________Merge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               9 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          2060          vph

__________________________________On Ramp Data_______________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0          mph
Volume on ramp                             360           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       2060        360                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               572         100                  v
Trucks and buses                      7           3                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                                    %           %            %
     Length                                   mi          mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.966       0.957
Driver population factor, fP          1.00        1.00
Flow rate, vp                         2369        418                  pcph

________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2369   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                            Actual        Maximum         LOS F?
     v                      2787          4800            No
      FO
     v     v                0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?          No
      3 or  av34
Is   v     v        > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                            (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area____________________
                       Actual        Max Desirable        Violation?
     v                 2369          4400                 No
      12                                                                    !
_________________Level of Service Determination (if not F)__________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   22.0    pc/mi/ln
          R                  R            12           A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation________________________________

Intermediate speed variable,                M  = 0.328
                                             S
Space mean speed in ramp influence area,    S  = 60.8    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 60.8    mph
_____________________________________________________________________________
```

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                HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                          Fax:
E-mail:

_________________________________Diverge Analysis____________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          2420          vph

_________________________________Off Ramp Data_______________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0          mph
Volume on ramp                             620           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       2420        620                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               672         172                  v
Trucks and buses                      9           4                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %            %
     Length                           0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.957       0.943
Driver population factor, fP          1.00        1.00
Flow rate, vp                         2810        730                  pcph

________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2810   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_______________________________

                            Actual        Maximum         LOS F?
     v  = v                 2810          4800            No
      Fi   F
     v  = v - v             2080          4800            No
      FO   F   R
     v                      730           2000            No
      R
     v     v                0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?          No
      3 or  av34
Is   v     v        > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area__________________
                       Actual        Max Desirable        Violation?
     v                 2810          4600                 No
      12                                                                    !
_________________Level of Service Determination (if not F)__________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   21.2    pc/mi/ln
                                           R          12        D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation________________________________

Intermediate speed variable,                D  = 0.494
                                             S
Space mean speed in ramp influence area,    S  = 56.2    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 56.2    mph
_____________________________________________________________________________
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2015 Gardner No Action - PM Peak Hour - HCS Freeway Ramps

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                   HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                      Fax:
E-mail:

_________________________________Merge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1800          vph

__________________________________On Ramp Data_______________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              110           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1800        110                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 500         31                    v
Trucks and buses                        9           6                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.957       0.917
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2090        133                     pcph

_________________________Estimation of V12 Merge Areas_______________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2090   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum        LOS F?
     v                     2223          4800           No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area___________________
                      Actual        Max Desirable          Violation?
     v                2090          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   17.7    pc/mi/ln
          R                   R           12           A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation________________________________

Intermediate speed variable,                M  = 0.301
                                             S
Space mean speed in ramp influence area,    S  = 61.6    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 61.6    mph
_____________________________________________________________________________
```

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                   HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                      Fax:
E-mail:

_________________________________Diverge Analysis____________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1910          vph

_________________________________Off Ramp Data_______________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              440           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1910        440                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 531         122                   v
Trucks and buses                        11          1                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                              0.00   %    0.00   %            %
     Length                             0.00   mi   0.00   mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.948       0.985
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2239        496                     pcph

_________________________Estimation of V12 Diverge Areas_____________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2239   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_______________________________

                           Actual        Maximum        LOS F?
     v  = v                2239          4800           No
      Fi   F
     v  = v - v            1743          4800           No
      FO   F   R
     v                     496           2000           No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable          Violation?
     v                2239          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)___________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   16.3    pc/mi/ln
                                          R          12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation________________________________

Intermediate speed variable,                D  = 0.473
                                             S
Space mean speed in ramp influence area,    S  = 56.8    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 56.8    mph
_____________________________________________________________________________
```

2015 Gardner No Action - PM Peak Hour - HCS Freeway Ramps

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                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:03:18 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1910           vph

________________________________Off Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0           mph
Volume on ramp                             420            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1910        420                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                531         117                 v
Trucks and buses                       11          1                   %
Recreational vehicles                  0           0                   %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %           %
     Length                            0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.948       0.985
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2239        474                    pcph

________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2239   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                2239          4800            No
      Fi   F
     v  = v - v            1765          4800            No
      FO   F   R
     v                     474           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                2239          4600                   No
      12                                                                       !
________________Level of Service Determination (if not F)_____________________

Density,            D = 4.252 + 0.0086 v  - 0.009  L   =   16.3    pc/mi/ln
                       R                12          D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation________________________________

Intermediate speed variable,                  D  = 0.471
                                               S
Space mean speed in ramp influence area,      S  = 56.8    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 56.8    mph
_______________________________________________________________________________
```

```
                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:03:18 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1490           vph

_________________________________On Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             40             vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1490        40                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                414         11                  v
Trucks and buses                       11          5                   %
Recreational vehicles                  0           0                   %
Terrain type:                          Level       Rolling
     Grade                                     %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.948       0.930
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1747        48                     pcph

________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1747   pc/h
                   12   F   FM

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1795          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1747          4400                   No
      12                                                                       !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   14.4    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation________________________________

Intermediate speed variable,                  M  = 0.288
                                               S
Space mean speed in ramp influence area,      S  = 61.9    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 61.9    mph
_______________________________________________________________________________
```

2015 Gardner IMF Operations - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_______Operational Analysis_______

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/3/2008 1:54:13 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: Edgerton Road to Sunflower Road
Jurisdiction:
Analysis Year: 2015
Description: NEPA Traffic Study

_______Flow Inputs and Adjustments_______

Volume, V	1305	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	363	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	761	pc/h/ln

_______Speed Inputs and Adjustments_______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______LOS and Performance Measures_______

Flow rate, vp	761	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	10.9	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_______Operational Analysis_______

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/3/2008 1:54:13 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: Sunflower Road to Gardner Road
Jurisdiction: KDOT
Analysis Year: 2015
Description: NEPA Traffic Study

_______Flow Inputs and Adjustments_______

Volume, V	1710	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	475	v
Trucks and buses	8	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.962	
Driver population factor, fp	1.00	
Flow rate, vp	988	pc/h/ln

_______Speed Inputs and Adjustments_______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______LOS and Performance Measures_______

Flow rate, vp	988	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	14.1	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2015 Gardner IMF Operations - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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________________________Operational Analysis__________________________________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/3/2008 1:54:13 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Gardner Road to US 56
Jurisdiction:	KDOT
Analysis Year:	2015
Description:	NEPA Traffic Study

________________________Flow Inputs and Adjustments___________________________

Volume, V	2390	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	664	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1394	pc/h/ln

________________________Speed Inputs and Adjustments__________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

________________________LOS and Performance Measures__________________________

Flow rate, vp	1394	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	19.9	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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________________________Operational Analysis__________________________________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/3/2008 1:54:13 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	US 56 to 151st Street
Jurisdiction:	KDOT
Analysis Year:	2015
Description:	NEPA Traffic Study

________________________Flow Inputs and Adjustments___________________________

Volume, V	3880	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1078	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2220	pc/h/ln

________________________Speed Inputs and Adjustments__________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

________________________LOS and Performance Measures__________________________

Flow rate, vp	2220	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	59.5	mi/h
Number of lanes, N	2	
Density, D	37.3	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

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_______________Operational Analysis_______________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/3/2008 1:54:13 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	151Street to US 56
Jurisdiction:	KDOT
Analysis Year:	2015
Description:	NEPA Traffic Study

_______________Flow Inputs and Adjustments_______________

Volume, V	1810	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	503	v
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.948	
Driver population factor, fp	1.00	
Flow rate, vp	1061	pc/h/ln

_______________Speed Inputs and Adjustments_______________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______________LOS and Performance Measures_______________

Flow rate, vp	1061	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	15.2	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

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_______________Operational Analysis_______________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/3/2008 1:54:13 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	US 56 to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2015
Description:	NEPA Traffic Study

_______________Flow Inputs and Adjustments_______________

Volume, V	770	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	214	v
Trucks and buses	24	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.893	
Driver population factor, fp	1.00	
Flow rate, vp	479	pc/h/ln

_______________Speed Inputs and Adjustments_______________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______________LOS and Performance Measures_______________

Flow rate, vp	479	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	6.8	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

2015 Gardner IMF Operations - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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_________________________Operational Analysis__________________________________

Analyst:                Tom Hiles
Agency or Company:      HDR Inc.
Date Performed:         4/3/2008 1:54:13 PM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Southbound
From/To:                Gardner Road to Sunflower Road
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                    630           veh/h
Peak-hour factor, PHF                        0.90
Peak 15-min volume, v15                      175           v
Trucks and buses                             18            %
Recreational vehicles                        0             %
Terrain type:                                Level
    Grade                                    0.00          %
    Segment length                           0.00          mi
Trucks and buses PCE, ET                     1.5
Recreational vehicle PCE, ER                 1.2
Heavy vehicle adjustment, fHV                0.917
Driver population factor, fp                 1.00
Flow rate, vp                                382           pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                   12.0          ft
Right-shoulder lateral clearance             6.0           ft
Interchange density                          0.50          interchange/mi
Number of lanes, N                           2
Free-flow speed:                             Measured
     FFS or BFFS                             70.0          mi/h
Lane width adjustment, fLW                   0.0           mi/h
Lateral clearance adjustment, fLC            0.0           mi/h
Interchange density adjustment, fID          0.0           mi/h
Number of lanes adjustment, fN               0.0           mi/h
Free-flow speed, FFS                         70.0          mi/h
                                             Rural Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                                382           pc/h/ln
Free-flow speed, FFS                         70.0          mi/h
Average passenger-car speed, S               70.0          mi/h
Number of lanes, N                           2
Density, D                                   5.5           pc/mi/ln
Level of service, LOS                                      A

  Overall results are not computed when free-flow speed is less than 55 mph.
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_________________________Operational Analysis__________________________________

Analyst:                Tom Hiles
Agency or Company:      HDR Inc.
Date Performed:         4/3/2008 1:54:13 PM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Southbound
From/To:                Sunflower Road to Edgerton Road
Jurisdiction:
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                    565           veh/h
Peak-hour factor, PHF                        0.90
Peak 15-min volume, v15                      157           v
Trucks and buses                             20            %
Recreational vehicles                        0             %
Terrain type:                                Level
    Grade                                    0.00          %
    Segment length                           0.00          mi
Trucks and buses PCE, ET                     1.5
Recreational vehicle PCE, ER                 1.2
Heavy vehicle adjustment, fHV                0.909
Driver population factor, fp                 1.00
Flow rate, vp                                345           pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                   12.0          ft
Right-shoulder lateral clearance             6.0           ft
Interchange density                          0.50          interchange/mi
Number of lanes, N                           2
Free-flow speed:                             Measured
     FFS or BFFS                             70.0          mi/h
Lane width adjustment, fLW                   0.0           mi/h
Lateral clearance adjustment, fLC            0.0           mi/h
Interchange density adjustment, fID          0.0           mi/h
Number of lanes adjustment, fN               0.0           mi/h
Free-flow speed, FFS                         70.0          mi/h
                                             Rural Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                                345           pc/h/ln
Free-flow speed, FFS                         70.0          mi/h
Average passenger-car speed, S               70.0          mi/h
Number of lanes, N                           2
Density, D                                   4.9           pc/mi/ln
Level of service, LOS                                      A

  Overall results are not computed when free-flow speed is less than 55 mph.
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_________________________Operational Analysis________________________________

Analyst:                 Tom Hiles
Agency or Company:       HDR Inc.
Date Performed:          4/3/2008 1:54:13 PM
Analysis Time Period:    PM
Freeway/Direction:       I-35 Northbound
From/To:                 Edgerton Road to Sunflower Road
Jurisdiction:
Analysis Year:           2015
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments_________________________

Volume, V                                  775           veh/h
Peak-hour factor, PHF                      0.90
Peak 15-min volume, v15                    215           v
Trucks and buses                           22            %
Recreational vehicles                      0             %
Terrain type:                              Level
    Grade                                  0.00          %
    Segment length                         0.00          mi
Trucks and buses PCE, ET                   1.5
Recreational vehicle PCE, ER               1.2
Heavy vehicle adjustment, fHV              0.901
Driver population factor, fp               1.00
Flow rate, vp                              478           pc/h/ln

_________________________Speed Inputs and Adjustments________________________

Lane width                                 12.0          ft
Right-shoulder lateral clearance           6.0           ft
Interchange density                        0.50          interchange/mi
Number of lanes, N                         2
Free-flow speed:                           Measured
     FFS or BFFS                           70.0          mi/h
Lane width adjustment, fLW                 0.0           mi/h
Lateral clearance adjustment, fLC          0.0           mi/h
Interchange density adjustment, fID        0.0           mi/h
Number of lanes adjustment, fN             0.0           mi/h
Free-flow speed, FFS                       70.0          mi/h
                                           Rural Freeway

_________________________LOS and Performance Measures________________________

Flow rate, vp                              478           pc/h/ln
Free-flow speed, FFS                       70.0          mi/h
Average passenger-car speed, S             70.0          mi/h
Number of lanes, N                         2
Density, D                                 6.8           pc/mi/ln
Level of service, LOS                      A

  Overall results are not computed when free-flow speed is less than 55 mph.
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_________________________Operational Analysis________________________________

Analyst:                 Tom Hiles
Agency or Company:       HDR Inc.
Date Performed:          4/3/2008 1:54:13 PM
Analysis Time Period:    PM
Freeway/Direction:       I-35 Northbound
From/To:                 Sunflower Road to Gardner Road
Jurisdiction:            KDOT
Analysis Year:           2015
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments_________________________

Volume, V                                  910           veh/h
Peak-hour factor, PHF                      0.90
Peak 15-min volume, v15                    253           v
Trucks and buses                           19            %
Recreational vehicles                      0             %
Terrain type:                              Level
    Grade                                  0.00          %
    Segment length                         0.00          mi
Trucks and buses PCE, ET                   1.5
Recreational vehicle PCE, ER               1.2
Heavy vehicle adjustment, fHV              0.913
Driver population factor, fp               1.00
Flow rate, vp                              554           pc/h/ln

_________________________Speed Inputs and Adjustments________________________

Lane width                                 12.0          ft
Right-shoulder lateral clearance           6.0           ft
Interchange density                        0.50          interchange/mi
Number of lanes, N                         2
Free-flow speed:                           Measured
     FFS or BFFS                           70.0          mi/h
Lane width adjustment, fLW                 0.0           mi/h
Lateral clearance adjustment, fLC          0.0           mi/h
Interchange density adjustment, fID        0.0           mi/h
Number of lanes adjustment, fN             0.0           mi/h
Free-flow speed, FFS                       70.0          mi/h
                                           Rural Freeway

_________________________LOS and Performance Measures________________________

Flow rate, vp                              554           pc/h/ln
Free-flow speed, FFS                       70.0          mi/h
Average passenger-car speed, S             70.0          mi/h
Number of lanes, N                         2
Density, D                                 7.9           pc/mi/ln
Level of service, LOS                      A

  Overall results are not computed when free-flow speed is less than 55 mph.
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2015 Gardner IMF Operations - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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_________________________Operational Analysis__________________________________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/3/2008 1:54:13 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Gardner Road to US 56
Jurisdiction:	KDOT
Analysis Year:	2015

Description: NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V	1220	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	339	v
Trucks and buses	21	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.905	
Driver population factor, fp	1.00	
Flow rate, vp	749	pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_________________________LOS and Performance Measures__________________________

Flow rate, vp	749	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	10.7	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

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_________________________Operational Analysis__________________________________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/3/2008 1:54:13 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	US 56 to 151st Street
Jurisdiction:	KDOT
Analysis Year:	2015

Description: NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V	2230	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	619	v
Trucks and buses	13	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.939	
Driver population factor, fp	1.00	
Flow rate, vp	1319	pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_________________________LOS and Performance Measures__________________________

Flow rate, vp	1319	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	18.8	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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________________________Operational Analysis_________________________________

Analyst:                Tom Hiles
Agency or Company:      HDR Inc.
Date Performed:         4/3/2008 1:54:13 PM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Southbound
From/To:                151Street to US 56
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

________________________Flow Inputs and Adjustments__________________________

Volume, V                                  3680          veh/h
Peak-hour factor, PHF                      0.90
Peak 15-min volume, v15                    1022          v
Trucks and buses                           9             %
Recreational vehicles                      0             %
Terrain type:                              Level
    Grade                                  0.00          %
    Segment length                         0.00          mi
Trucks and buses PCE, ET                   1.5
Recreational vehicle PCE, ER               1.2
Heavy vehicle adjustment, fHV              0.957
Driver population factor, fp               1.00
Flow rate, vp                              2136          pc/h/ln

________________________Speed Inputs and Adjustments_________________________

Lane width                                 12.0          ft
Right-shoulder lateral clearance           6.0           ft
Interchange density                        0.50          interchange/mi
Number of lanes, N                         2
Free-flow speed:                           Measured
     FFS or BFFS                           70.0          mi/h
Lane width adjustment, fLW                 0.0           mi/h
Lateral clearance adjustment, fLC          0.0           mi/h
Interchange density adjustment, fID        0.0           mi/h
Number of lanes adjustment, fN             0.0           mi/h
Free-flow speed, FFS                       70.0          mi/h
                                           Rural Freeway

________________________LOS and Performance Measures_________________________

Flow rate, vp                              2136          pc/h/ln
Free-flow speed, FFS                       70.0          mi/h
Average passenger-car speed, S             61.8          mi/h
Number of lanes, N                         2
Density, D                                 34.5          pc/mi/ln
Level of service, LOS                      D

  Overall results are not computed when free-flow speed is less than 55 mph.
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HCS+: Basic Freeway Segments Release 5.21

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________________________Operational Analysis_________________________________

Analyst:                Tom Hiles
Agency or Company:      HDR Inc.
Date Performed:         4/3/2008 1:54:13 PM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Southbound
From/To:                US 56 to Gardner Road
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

________________________Flow Inputs and Adjustments__________________________

Volume, V                                  2520          veh/h
Peak-hour factor, PHF                      0.90
Peak 15-min volume, v15                    700           v
Trucks and buses                           13            %
Recreational vehicles                      0             %
Terrain type:                              Level
    Grade                                  0.00          %
    Segment length                         0.00          mi
Trucks and buses PCE, ET                   1.5
Recreational vehicle PCE, ER               1.2
Heavy vehicle adjustment, fHV              0.939
Driver population factor, fp               1.00
Flow rate, vp                              1491          pc/h/ln

________________________Speed Inputs and Adjustments_________________________

Lane width                                 12.0          ft
Right-shoulder lateral clearance           6.0           ft
Interchange density                        0.50          interchange/mi
Number of lanes, N                         2
Free-flow speed:                           Measured
     FFS or BFFS                           70.0          mi/h
Lane width adjustment, fLW                 0.0           mi/h
Lateral clearance adjustment, fLC          0.0           mi/h
Interchange density adjustment, fID        0.0           mi/h
Number of lanes adjustment, fN             0.0           mi/h
Free-flow speed, FFS                       70.0          mi/h
                                           Rural Freeway

________________________LOS and Performance Measures_________________________

Flow rate, vp                              1491          pc/h/ln
Free-flow speed, FFS                       70.0          mi/h
Average passenger-car speed, S             69.8          mi/h
Number of lanes, N                         2
Density, D                                 21.4          pc/mi/ln
Level of service, LOS                      C

  Overall results are not computed when free-flow speed is less than 55 mph.
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2015 Gardner IMF Operations - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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______________________Operational Analysis______________________________

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/3/2008 1:54:13 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: Gardner Road to Sunflower Road
Jurisdiction: KDOT
Analysis Year: 2015
Description: NEPA Traffic Study

______________________Flow Inputs and Adjustments_______________________

Volume, V	1910	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	531	v
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.948	
Driver population factor, fp	1.00	
Flow rate, vp	1119	pc/h/ln

______________________Speed Inputs and Adjustments______________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

______________________LOS and Performance Measures______________________

Flow rate, vp	1119	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	16.0	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

______________________Operational Analysis______________________________

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/3/2008 1:54:13 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: Sunflower Road to Edgerton Road
Jurisdiction:
Analysis Year: 2015
Description: NEPA Traffic Study

______________________Flow Inputs and Adjustments_______________________

Volume, V	1530	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	425	v
Trucks and buses	13	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.939	
Driver population factor, fp	1.00	
Flow rate, vp	905	pc/h/ln

______________________Speed Inputs and Adjustments______________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

______________________LOS and Performance Measures______________________

Flow rate, vp	905	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	12.9	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2015 Gardner IMF Operations - AM Peak Hour - HCS Freeway Ramps

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                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1305          vph

_________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              25            vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1305        25                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                363         7                    v
Trucks and buses                       10          4                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.952       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1523        29                        pcph

_________________________Estimation of V12 Diverge Areas_________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1523   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v  = v                1523          4800            No
      Fi   F
     v  = v - v            1494          4800            No
      FO   F   R
     v                     29            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1523          4600                   No
      12                                                                        !
_________________Level of Service Determination (if not F)_____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   10.1    pc/mi/ln
                      R                  12          D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.431
                                              S
Space mean speed in ramp influence area,     S  = 57.9    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.9    mph
_________________________________________________________________________________
```

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                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1280          vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              430           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1280        430                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                356         119                  v
Trucks and buses                       10          1                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.952       0.985
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1493        485                       pcph

_________________________Estimation of V12 Merge Areas___________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1493   pc/h
                   12   F   FM

_______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v                     1978          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                1493          4400                   No
      12                                                                        !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   15.7    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.293
                                              S
Space mean speed in ramp influence area,     S  = 61.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.8    mph
_________________________________________________________________________________
```

2015 Gardner IMF Operations - AM Peak Hour - HCS Freeway Ramps

HCS+: Ramps and Ramp Junctions Release 5.21

Phone: Fax:
E-mail:

Diverge Analysis

Analyst: Tom Hiles
Agency/Co.: HDR Inc.
Date performed: 4/3/2008 1:54:13 PM
Analysis time period: AM
Freeway/Dir of Travel: I-35 Northbound
Junction: 3 Gardner Exit
Jurisdiction: KDOT
Analysis Year: 2015
Description: NEPA Traffic Study

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1710	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	120	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1710	120		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	475	33		v
Trucks and buses	8	3		%
Recreational vehicles	0	0		%
Terrain type:	Level	Rolling		
Grade	0.00 %	0.00 %	%	
Length	0.00 mi	0.00 mi	mi	
Trucks and buses PCE, ET	1.5*	2.5		
Recreational vehicle PCE, ER	1.2*	2.0		
Heavy vehicle adjustment, fHV	0.962	0.957		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	1976	139		pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 1976 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	1976	4800	No
$v_{FO} = v_F - v_R$	1837	4800	No
v_R	139	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} =		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1976	4600	No !

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ = 14.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, D_S = 0.441

Space mean speed in ramp influence area, S_R = 57.7 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 57.7 mph

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Phone: Fax:
E-mail:

Merge Analysis

Analyst: Tom Hiles
Agency/Co.: HDR Inc.
Date performed: 4/3/2008 1:54:13 PM
Analysis time period: AM
Freeway/Dir of Travel: I-35 Northbound
Junction: 4 Gardner Entr
Jurisdiction: KDOT
Analysis Year: 2015
Description: NEPA Traffic Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1590	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	800	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1590	800		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	442	222		v
Trucks and buses	8	13		%
Recreational vehicles	0	0		%
Terrain type:	Level	Rolling		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5*	2.5		
Recreational vehicle PCE, ER	1.2*	2.0		
Heavy vehicle adjustment, fHV	0.962	0.837		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	1837	1062		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1837 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2899	4800	No
v_3 or v_{av34}	0 pc/h	(Equation 25-4 or 25-5)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} =		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1837	4400	No !

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 22.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, M_S = 0.336

Space mean speed in ramp influence area, S_R = 60.6 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 60.6 mph

2015 Gardner IMF Operations - AM Peak Hour - HCS Freeway Ramps

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                  HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                               Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0            mph
Volume on freeway                         2390            vph

_________________________________Off Ramp Data___________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0            mph
Volume on ramp                            280             vph
Length of first accel/decel lane          800             ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                  Freeway     Ramp        Adjacent
                                                             Ramp
Volume, V (vph)                      2390        280                  vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              664         78                   v
Trucks and buses                     10          7                    %
Recreational vehicles                0           0                    %
Terrain type:                        Level       Rolling
     Grade                           0.00    %   0.00    %            %
     Length                          0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
Heavy vehicle adjustment, fHV        0.952       0.905
Driver population factor, fP         1.00        1.00
Flow rate, vp                        2788        344                      pcph

_________________________Estimation of V12 Diverge Areas_________________________

                 L  =             (Equation 25-8 or 25-9)
                  EQ
                 P  =    1.000   Using Equation  0
                  FD
                 v  = v  + (v - v ) P  =  2788   pc/h
                  12   R     F   R   FD

_______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v  = v                2788          4800            No
      Fi   F
     v  = v - v            2444          4800            No
      FO   F   R
     v                     344           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2788          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L  =   21.0    pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence C

_______________________________Speed Estimation_________________________________

Intermediate speed variable,                D  = 0.459
                                             S
Space mean speed in ramp influence area,    S  = 57.1    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.1    mph
________________________________________________________________________________
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                  HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                               Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0            mph
Volume on freeway                         3740            vph

__________________________________On Ramp Data___________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0            mph
Volume on ramp                            140             vph
Length of first accel/decel lane          1000            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                  Freeway     Ramp        Adjacent
                                                             Ramp
Volume, V (vph)                      3740        140                  vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              1039        39                   v
Trucks and buses                     10          2                    %
Recreational vehicles                0           0                    %
Terrain type:                        Level       Rolling
     Grade                                   %           %            %
     Length                                  mi          mi           mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
Heavy vehicle adjustment, fHV        0.952       0.971
Driver population factor, fP         1.00        1.00
Flow rate, vp                        4363        160                      pcph

_________________________Estimation of V12 Merge Areas___________________________

                 L  =             (Equation 25-2 or 25-3)
                  EQ
                 P  =    1.000   Using Equation  0
                  FM
                 v  = v  (P  ) =  4363   pc/h
                  12   F   FM

_______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v                     4523          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                4363          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L  =   34.4    pc/mi/ln
          R                R          12            A
Level of service for ramp-freeway junction areas of influence  D

_______________________________Speed Estimation_________________________________

Intermediate speed variable,                M  = 0.610
                                             S
Space mean speed in ramp influence area,    S  = 52.9    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 52.9    mph
________________________________________________________________________________
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Phone:                                  Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2110          vph

_________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              1630          vph
Length of first accel/decel lane            500           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2110        1630                 vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 586         453                  v
Trucks and buses                        10          2                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %           %
     Length                                     mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.952       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2462        1865                 pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2462   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
    v                      4327          4800            No
     FO
    v     v                0    pc/h     (Equation 25-4 or 25-5)
     3 or  av34
Is   v     v      > 2700 pc/h?           No
     3 or  av34
Is   v     v      > 1.5 v  /2            No
     3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                     Actual        Max Desirable         Violation?
    v                2462          4400                  No
     12                                                                      !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   35.2    pc/mi/ln
          R                  R           12            A
Level of service for ramp-freeway junction areas of influence  E

____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.581
                                              S
Space mean speed in ramp influence area,     S  = 53.7    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 53.7    mph
_______________________________________________________________________________
```

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                HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
E-mail:

_______________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               8 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1810          vph

________________________________Off Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     45.0          mph
Volume on ramp                              1120          vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1810        1120                 vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 503         311                  v
Trucks and buses                        11          3                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %           %
     Length                             0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.948       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2122        1300                 pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2122   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
      v  = v               2122          4800            No
       Fi   F
      v  = v - v           822           4800            No
       FO   F   R
      v                    1300          2100            No
       R
      v     v              0    pc/h     (Equation 25-15 or 25-16)
       3 or  av34
Is    v     v     > 2700 pc/h?           No
       3 or  av34
Is    v     v     > 1.5 v  /2            No
       3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                     Actual        Max Desirable         Violation?
      v              2122          4600                  No
       12                                                                    !
________________Level of Service Determination (if not F)_____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   15.3    pc/mi/ln
                      R                 12           D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.415
                                              S
Space mean speed in ramp influence area,     S  = 58.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 58.4    mph
_______________________________________________________________________________
```

2015 Gardner IMF Operations - AM Peak Hour - HCS Freeway Ramps

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                  HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
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________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               9 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                         Merge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0          mph
Volume on freeway                        690           vph

_________________________________On Ramp Data_________________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-flow speed on ramp                  35.0          mph
Volume on ramp                           80            vph
Length of first accel/decel lane         800           ft
Length of second accel/decel lane                      ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                No
Volume on adjacent Ramp                                vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                              ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                  Freeway     Ramp        Adjacent
                                                             Ramp
Volume, V (vph)                      690         80                   vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              192         22                   v
Trucks and buses                     11          15                   %
Recreational vehicles                0           0                    %
Terrain type:                        Level       Rolling
     Grade                                   %           %            %
     Length                                  mi          mi           mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.948       0.816
Driver population factor, fP           1.00        1.00
Flow rate, vp                          809         109                      pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  809    pc/h
                   12   F   FM

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     918           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                809           4400                  No
      12                                                                       !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   7.6     pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  A

____________________________Speed Estimation__________________________________

Intermediate speed variable,               M  = 0.275
                                            S
Space mean speed in ramp influence area,   S  = 62.3    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 62.3    mph
_______________________________________________________________________________
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Phone:                                   Fax:
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________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                         Diverge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0          mph
Volume on freeway                        770           vph

________________________________Off Ramp Data_________________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-Flow speed on ramp                  35.0          mph
Volume on ramp                           210           vph
Length of first accel/decel lane         800           ft
Length of second accel/decel lane                      ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                No
Volume on adjacent ramp                                vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                              ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                  Freeway     Ramp        Adjacent
                                                             Ramp
Volume, V (vph)                      770         210                  vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              214         58                   v
Trucks and buses                     24          0                    %
Recreational vehicles                0           0                    %
Terrain type:                        Level       Rolling
     Grade                           0.00    %   0.00    %            %
     Length                          0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
```

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Heavy vehicle adjustment, fHV          0.893       1.000
Driver population factor, fP           1.00        1.00
Flow rate, vp                          958         233                      pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  958    pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                958           4800            No
      Fi   F
     v  = v - v            725           4800            No
      FO   F   R
     v                     233           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                958           4600                  No
      12                                                                       !
________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   5.3     pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence A

____________________________Speed Estimation__________________________________

Intermediate speed variable,               D  = 0.449
                                            S
Space mean speed in ramp influence area,   S  = 57.4    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 57.4    mph
_______________________________________________________________________________
```

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Phone:                                      Fax:
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_________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           560           vph

__________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              70            vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         560         70                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 156         19                   v
Trucks and buses                        24          7                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.893       0.905
Driver population factor, fP            1.00        1.00
Flow rate, vp                           697         86                   pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  697    pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v                     783           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                697           4400                  No
      12                                                                   !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   6.5     pc/mi/ln
          R                   R          12            A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                  M  = 0.274
                                               S
Space mean speed in ramp influence area,      S  = 62.3    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 62.3    mph
_______________________________________________________________________________
```

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Phone:                                      Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           630           vph

_________________________________Off Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              90            vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         630         90                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 175         25                   v
Trucks and buses                        18          2                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.917       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           763         103                  pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  763    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v  = v                763           4800            No
      Fi   F
     v  = v - v            660           4800            No
      FO   F   R
     v                     103           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                763           4600                  No
      12                                                                   !
________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   3.6     pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                  D  = 0.437
                                               S
Space mean speed in ramp influence area,      S  = 57.8    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 57.8    mph
_______________________________________________________________________________
```

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Phone: Fax:
E-mail:

Merge Analysis

Analyst: Tom Hiles
Agency/Co.: HDR Inc.
Date performed: 4/3/2008 1:54:13 PM
Analysis time period: AM
Freeway/Dir of Travel: I-35 Southbound
Junction: 13 Sunflower Entr
Jurisdiction: KDOT
Analysis Year: 2015
Description: NEPA Traffic Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	540	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	25	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	540	25		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	150	7		v
Trucks and buses	18	0		%
Recreational vehicles	0	0		%
Terrain type:	Level	Rolling		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5*	2.5		
Recreational vehicle PCE, ER	1.2*	2.0		
Heavy vehicle adjustment, fHV	0.917	1.000		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	654	28		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)
P_{FM} = 1.000 Using Equation 0
$v_{12} = v_F (P_{FM})$ = 654 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	682	4800	No
$v_{3 \text{ or } av34}$	0 pc/h	(Equation 25-4 or 25-5)	
Is $v_{3 \text{ or } av34}$ > 2700 pc/h?		No	
Is $v_{3 \text{ or } av34}$ > 1.5 v_{12}/2		No	
If yes, v_{12A} =		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	654	4400	No

!

Level of Service Determination (if not F)

Density, $D = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 5.8 pc/mi/ln
Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable, M_S = 0.273

Space mean speed in ramp influence area, S_R = 62.4 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 62.4 mph

```
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_________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           775           vph

_________________________________Off Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              25            vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         775         25                    vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 215         7                     v
Trucks and buses                        22          0                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %             %
     Length                             0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.901       1.000
Driver population factor, fP            1.00        1.00
Flow rate, vp                           956         28                      pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  956    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                956           4800            No
      Fi   F
     v  = v - v            928           4800            No
      FO   F   R
     v                     28            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                956           4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =    5.3     pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence A

________________________________Speed Estimation_______________________________

Intermediate speed variable,                 D  = 0.431
                                              S
Space mean speed in ramp influence area,     S  = 57.9    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.9    mph
_______________________________________________________________________________
```

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Phone:                                      Fax:
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_________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           750           vph

__________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              160           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         750         160                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 208         44                    v
Trucks and buses                        22          3                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                                      %           %             %
     Length                                     mi          mi            mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.901       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           925         186                     pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  925    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1111          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                925           4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =    9.0     pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  A

________________________________Speed Estimation_______________________________

Intermediate speed variable,                 M  = 0.277
                                              S
Space mean speed in ramp influence area,     S  = 62.2    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.2    mph
_______________________________________________________________________________
```

2015 Gardner IMF Operations - PM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                      Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           910            vph

_________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              70             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        910         70                    vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                253         19                    v
Trucks and buses                       19          11                    %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %             %
     Length                            0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.913       0.858
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1107        91                         pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1107   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                            Actual        Maximum         LOS F?
     v  = v                 1107          4800            No
      Fi   F
     v  = v - v             1016          4800            No
      FO   F   R
     v                      91            2000            No
      R
     v     v                0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?            No
      3 or  av34
Is   v     v      > 1.5 v  /2             No
      3 or  av34         12
If yes, v    =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                       Actual        Max Desirable          Violation?
     v                 1107          4600                   No
      12                                                                     !
_________________Level of Service Determination (if not F)_____________________

Density,            D = 4.252 + 0.0086 v  - 0.009  L   =   6.6     pc/mi/ln
                     R                    12         D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                 D  = 0.436
                                              S
Space mean speed in ramp influence area,     S  = 57.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.8    mph
________________________________________________________________________________
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Phone:                                      Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           840            vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              380            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        840         380                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                233         106                   v
Trucks and buses                       19          0                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                                     %           %             %
     Length                                    mi          mi            mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.913       1.000
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1022        422                        pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1022   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                            Actual        Maximum         LOS F?
     v                      1444          4800            No
      FO
     v     v                0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?            No
      3 or  av34
Is   v     v      > 1.5 v  /2             No
      3 or  av34         12
If yes, v    =                            (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                       Actual        Max Desirable          Violation?
     v                 1022          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   11.5    pc/mi/ln
          R                   R          12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                 M  = 0.282
                                              S
Space mean speed in ramp influence area,     S  = 62.1    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.1    mph
________________________________________________________________________________
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Phone:                                      Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1220           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              130            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1220        130                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 339         36                   v
Trucks and buses                        21          11                   %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.905       0.858
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1498        168                  pcph

_________________________Estimation of V12 Diverge Areas_________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1498   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v  = v                1498          4800            No
      Fi   F
     v  = v - v            1330          4800            No
      FO   F   R
     v                     168           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual       Max Desirable          Violation?
     v                1498         4600                   No
      12                                                                       !
_________________Level of Service Determination (if not F)______________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =    9.9     pc/mi/ln
                        R                12         D
Level of service for ramp-freeway junction areas of influence A

_______________________________Speed Estimation_________________________________

Intermediate speed variable,                D  = 0.443
                                             S
Space mean speed in ramp influence area,    S  = 57.6    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.6    mph
________________________________________________________________________________
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E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           2210           vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              20             vph
Length of first accel/decel lane            1000           ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2210        20                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 614         6                    v
Trucks and buses                        21          3                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.905       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2713        23                   pcph

__________________________Estimation of V12 Merge Areas__________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2713   pc/h
                   12   F   FM

_______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v                     2736          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area______________________
                      Actual       Max Desirable          Violation?
     v                2713         4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   20.5    pc/mi/ln
          R                   R            12           A
Level of service for ramp-freeway junction areas of influence  C

_______________________________Speed Estimation_________________________________

Intermediate speed variable,                M  = 0.311
                                             S
Space mean speed in ramp influence area,    S  = 61.3    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 61.3    mph
________________________________________________________________________________
```

```
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Phone:                                 Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                       Merge
Number of lanes in freeway             2
Free-flow speed on freeway             70.0          mph
Volume on freeway                      1090          vph

_________________________________On Ramp Data_________________________________

Side of freeway                        Right
Number of lanes in ramp                1
Free-flow speed on ramp                35.0          mph
Volume on ramp                         1120          vph
Length of first accel/decel lane       500           ft
Length of second accel/decel lane                    ft

_______________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?              No
Volume on adjacent Ramp                              vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                            ft

___________________Conversion to pc/h Under Base Conditions__________________

Junction Components                Freeway     Ramp        Adjacent
                                                           Ramp
Volume, V (vph)                    1090        1120                  vph
Peak-hour factor, PHF              0.90        0.90
Peak 15-min volume, v15            303         311                   v
Trucks and buses                   21          3                     %
Recreational vehicles              0           0                     %
Terrain type:                      Level       Rolling
     Grade                                 %           %            %
     Length                               mi          mi           mi
Trucks and buses PCE, ET           1.5*        2.5
Recreational vehicle PCE, ER       1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.905        0.957
Driver population factor, fP           1.00         1.00
Flow rate, vp                          1338         1300                   pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =              (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1338   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v                     2638          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v     =                          (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1338          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   22.3    pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  C

______________________________Speed Estimation________________________________

Intermediate speed variable,               M  = 0.341
                                            S
Space mean speed in ramp influence area,   S  = 60.5    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 60.5    mph
______________________________________________________________________________
```

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Phone:                                 Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               8 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                       Diverge
Number of lanes in freeway             2
Free-flow speed on freeway             70.0          mph
Volume on freeway                      3680          vph

________________________________Off Ramp Data_________________________________

Side of freeway                        Right
Number of lanes in ramp                1
Free-Flow speed on ramp                45.0          mph
Volume on ramp                         1520          vph
Length of first accel/decel lane       800           ft
Length of second accel/decel lane                    ft

_______________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?              No
Volume on adjacent ramp                              vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                            ft

___________________Conversion to pc/h Under Base Conditions__________________

Junction Components                Freeway     Ramp        Adjacent
                                                           Ramp
Volume, V (vph)                    3680        1520                  vph
Peak-hour factor, PHF              0.90        0.90
Peak 15-min volume, v15            1022        422                   v
Trucks and buses                   9           2                     %
Recreational vehicles              0           0                     %
Terrain type:                      Level       Rolling
     Grade                         0.00    %   0.00    %            %
     Length                        0.00   mi   0.00   mi           mi
Trucks and buses PCE, ET           1.5*        2.5
Recreational vehicle PCE, ER       1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.957        0.971
Driver population factor, fP           1.00         1.00
Flow rate, vp                          4273         1740                   pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =              (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  4273   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v  = v                4273          4800            No
      Fi   F
     v  = v - v            2533          4800            No
      FO   F   R
     v                     1740          2100            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v     =                          (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                4273          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   33.8    pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence D

______________________________Speed Estimation________________________________

Intermediate speed variable,               D  = 0.455
                                            S
Space mean speed in ramp influence area,   S  = 57.3    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 57.3    mph
______________________________________________________________________________
```

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Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               9 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2160          vph

__________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              360           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)______________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2160        360                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 600         100                  v
Trucks and buses                        9           4                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %           %
     Length                                     mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.957       0.943
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2508        424                     pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2508   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2932          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area_______________________
                      Actual        Max Desirable          Violation?
     v                2508          4400                   No
      12                                                                        !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   23.1    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                M  = 0.338
                                             S
Space mean speed in ramp influence area,    S  = 60.5    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 60.5    mph
_______________________________________________________________________________
```

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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2520          vph

_________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              720           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)______________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2520        720                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 700         200                  v
Trucks and buses                        13          18                   %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %           %
     Length                             0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.939       0.787
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2982        1016                    pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2982   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                2982          4800            No
      Fi   F
     v  = v - v            1966          4800            No
      FO   F   R
     v                     1016          2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2982          4600                   No
      12                                                                        !
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   22.7    pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                D  = 0.519
                                             S
Space mean speed in ramp influence area,    S  = 55.5    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 55.5    mph
_______________________________________________________________________________
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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                  Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1800           vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              110            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1800        110                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 500         31                    v
Trucks and buses                        13          8                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                                      %           %           %
     Length                                     mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.939       0.893
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2130        137                    pcph

_________________________Estimation of V12 Merge Areas__________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2130   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     2267          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                2130          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   18.1    pc/mi/ln
          R                  R            12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                  M  = 0.303
                                               S
Space mean speed in ramp influence area,      S  = 61.5    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 61.5    mph
________________________________________________________________________________
```

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Phone:                                  Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1910           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              420            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1910        420                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 531         117                   v
Trucks and buses                        11          1                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %           %
     Length                             0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.948       0.985
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2239        474                    pcph

_________________________Estimation of V12 Diverge Areas________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2239   pc/h
                   12   R      F   R  FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                2239          4800            No
      Fi   F
     v  = v - v            1765          4800            No
      FO   F   R
     v                     474           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                2239          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   16.3    pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                  D  = 0.471
                                               S
Space mean speed in ramp influence area,      S  = 56.8    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 56.8    mph
________________________________________________________________________________
```

2015 Gardner IMF Operations - PM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                      Fax:
E-mail:

_________________________________Merge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:54:13 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1490          vph

__________________________________On Ramp Data________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              40            vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1490        40                    vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                414         11                    v
Trucks and buses                       11          5                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                                     %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.948       0.930
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1747        48                    pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1747   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v                     1795          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1747          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   14.4    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                 M  = 0.288
                                              S
Space mean speed in ramp influence area,     S  = 61.9    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.9    mph
______________________________________________________________________________
```

2030 Gardner No Action - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_________________________Operational Analysis__________________________________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:10:06 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Edgerton Road to Sunflower Road
Jurisdiction:	
Analysis Year:	2030
Description:	NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V	2400	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	667	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1393	pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_________________________LOS and Performance Measures__________________________

Flow rate, vp	1393	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	19.9	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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E-mail:

_________________________Operational Analysis__________________________________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:10:06 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Gardner Road to US 56
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V	4360	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1211	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1663	pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_________________________LOS and Performance Measures__________________________

Flow rate, vp	1663	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	69.1	mi/h
Number of lanes, N	3	
Density, D	24.1	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Gardner No Action - AM Peak Hour - HCS Freeway Mainline

```
Level of service, LOS                        C
  Overall results are not computed when free-flow speed is less than 55 mph.
```

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Phone:                                      Fax:
E-mail:

_________________________Operational Analysis__________________________________

Analyst:                Tom Hiles
Agency or Company:      HDR Inc.
Date Performed:         4/1/2008 4:10:06 PM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Northbound
From/To:                Sunflower Road to Waverly Road
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                   2920          veh/h
Peak-hour factor, PHF                       0.90
Peak 15-min volume, v15                     811           v
Trucks and buses                            8             %
Recreational vehicles                       0             %
Terrain type:                               Level
    Grade                                   0.00          %
    Segment length                          0.00          mi
Trucks and buses PCE, ET                    1.5
Recreational vehicle PCE, ER                1.2
Heavy vehicle adjustment, fHV               0.962
Driver population factor, fp                1.00
Flow rate, vp                               1687          pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                  12.0          ft
Right-shoulder lateral clearance            6.0           ft
Interchange density                         0.50          interchange/mi
Number of lanes, N                          2
Free-flow speed:                            Measured
     FFS or BFFS                            70.0          mi/h
Lane width adjustment, fLW                  0.0           mi/h
Lateral clearance adjustment, fLC           0.0           mi/h
Interchange density adjustment, fID         0.0           mi/h
Number of lanes adjustment, fN              0.0           mi/h
Free-flow speed, FFS                        70.0          mi/h
                                            Rural Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                               1687          pc/h/ln
Free-flow speed, FFS                        70.0          mi/h
Average passenger-car speed, S              68.9          mi/h
Number of lanes, N                          2
Density, D                                  24.5          pc/mi/ln
```

```
Level of service, LOS                        E
  Overall results are not computed when free-flow speed is less than 55 mph.
```

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Phone:                                      Fax:
E-mail:

_________________________Operational Analysis__________________________________

Analyst:                Tom Hiles
Agency or Company:      HDR Inc.
Date Performed:         4/1/2008 4:10:06 PM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Northbound
From/To:                US 56 to 151st Street
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                   5690          veh/h
Peak-hour factor, PHF                       0.90
Peak 15-min volume, v15                     1581          v
Trucks and buses                            5             %
Recreational vehicles                       0             %
Terrain type:                               Level
    Grade                                   0.00          %
    Segment length                          0.00          mi
Trucks and buses PCE, ET                    1.5
Recreational vehicle PCE, ER                1.2
Heavy vehicle adjustment, fHV               0.976
Driver population factor, fp                1.00
Flow rate, vp                               2160          pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                  12.0          ft
Right-shoulder lateral clearance            6.0           ft
Interchange density                         0.50          interchange/mi
Number of lanes, N                          3
Free-flow speed:                            Measured
     FFS or BFFS                            70.0          mi/h
Lane width adjustment, fLW                  0.0           mi/h
Lateral clearance adjustment, fLC           0.0           mi/h
Interchange density adjustment, fID         0.0           mi/h
Number of lanes adjustment, fN              3.0           mi/h
Free-flow speed, FFS                        70.0          mi/h
                                            Urban Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                               2160          pc/h/ln
Free-flow speed, FFS                        70.0          mi/h
Average passenger-car speed, S              61.2          mi/h
Number of lanes, N                          3
Density, D                                  35.3          pc/mi/ln
```

2030 Gardner No Action - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

______Operational Analysis______

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:10:06 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: Waverly Road to Gardner Road
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

______Flow Inputs and Adjustments______

Volume, V	3260	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	906	v
Trucks and buses	7	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.966	
Driver population factor, fp	1.00	
Flow rate, vp	1250	pc/h/ln

______Speed Inputs and Adjustments______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	1.15	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	3.2	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

______LOS and Performance Measures______

Flow rate, vp	1250	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	17.9	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

______Operational Analysis______

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:10:06 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Southbound
From/To: 151Street to US 56
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

______Flow Inputs and Adjustments______

Volume, V	3480	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	967	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1347	pc/h/ln

______Speed Inputs and Adjustments______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

______LOS and Performance Measures______

Flow rate, vp	1347	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	19.2	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Gardner No Action - AM Peak Hour - HCS Freeway Mainline

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Level of service, LOS                        A

  Overall results are not computed when free-flow speed is less than 55 mph.
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                   HCS+: Basic Freeway Segments Release 5.21

Phone:                                      Fax:
E-mail:

_________________________Operational Analysis__________________________________

Analyst:                Tom Hiles
Agency or Company:      HDR Inc.
Date Performed:         4/1/2008 4:10:06 PM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Southbound
From/To:                Gardner Road to Waverly Road
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                   1630           veh/h
Peak-hour factor, PHF                       0.90
Peak 15-min volume, v15                     453            v
Trucks and buses                            15             %
Recreational vehicles                       0              %
Terrain type:                               Level
    Grade                                   0.00           %
    Segment length                          0.00           mi
Trucks and buses PCE, ET                    1.5
Recreational vehicle PCE, ER                1.2
Heavy vehicle adjustment, fHV               0.930
Driver population factor, fp                1.00
Flow rate, vp                               649            pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                  12.0           ft
Right-shoulder lateral clearance            6.0            ft
Interchange density                         1.15           interchange/mi
Number of lanes, N                          3
Free-flow speed:                            Measured
     FFS or BFFS                            70.0           mi/h
Lane width adjustment, fLW                  0.0            mi/h
Lateral clearance adjustment, fLC           0.0            mi/h
Interchange density adjustment, fID         3.2            mi/h
Number of lanes adjustment, fN              3.0            mi/h
Free-flow speed, FFS                        70.0           mi/h
                                            Urban Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                               649            pc/h/ln
Free-flow speed, FFS                        70.0           mi/h
Average passenger-car speed, S              70.0           mi/h
Number of lanes, N                          3
Density, D                                  9.3            pc/mi/ln
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Level of service, LOS                        A

  Overall results are not computed when free-flow speed is less than 55 mph.
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                   HCS+: Basic Freeway Segments Release 5.21

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_________________________Operational Analysis__________________________________

Analyst:                Tom Hiles
Agency or Company:      HDR Inc.
Date Performed:         4/1/2008 4:10:06 PM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Southbound
From/To:                Sunflower Road to Edgerton Road
Jurisdiction:
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                   1190           veh/h
Peak-hour factor, PHF                       0.90
Peak 15-min volume, v15                     331            v
Trucks and buses                            20             %
Recreational vehicles                       0              %
Terrain type:                               Level
    Grade                                   0.00           %
    Segment length                          0.00           mi
Trucks and buses PCE, ET                    1.5
Recreational vehicle PCE, ER                1.2
Heavy vehicle adjustment, fHV               0.909
Driver population factor, fp                1.00
Flow rate, vp                               727            pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                  12.0           ft
Right-shoulder lateral clearance            6.0            ft
Interchange density                         0.50           interchange/mi
Number of lanes, N                          2
Free-flow speed:                            Measured
     FFS or BFFS                            70.0           mi/h
Lane width adjustment, fLW                  0.0            mi/h
Lateral clearance adjustment, fLC           0.0            mi/h
Interchange density adjustment, fID         0.0            mi/h
Number of lanes adjustment, fN              0.0            mi/h
Free-flow speed, FFS                        70.0           mi/h
                                            Rural Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                               727            pc/h/ln
Free-flow speed, FFS                        70.0           mi/h
Average passenger-car speed, S              70.0           mi/h
Number of lanes, N                          2
Density, D                                  10.4           pc/mi/ln
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2030 Gardner No Action - AM Peak Hour - HCS Freeway Mainline

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                    HCS+: Basic Freeway Segments Release 5.21

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_________________________Operational Analysis__________________________________

Analyst:                 Tom Hiles
Agency or Company:       HDR Inc.
Date Performed:          4/1/2008 4:10:06 PM
Analysis Time Period:    AM
Freeway/Direction:       I-35 Southbound
From/To:                 US 56 to Gardner Road
Jurisdiction:            KDOT
Analysis Year:           2030
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                   2280           veh/h
Peak-hour factor, PHF                       0.90
Peak 15-min volume, v15                     633            v
Trucks and buses                            13             %
Recreational vehicles                       0              %
Terrain type:                               Level
    Grade                                   0.00           %
    Segment length                          0.00           mi
Trucks and buses PCE, ET                    1.5
Recreational vehicle PCE, ER                1.2
Heavy vehicle adjustment, fHV               0.939
Driver population factor, fp                1.00
Flow rate, vp                               899            pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                  12.0           ft
Right-shoulder lateral clearance            6.0            ft
Interchange density                         0.50           interchange/mi
Number of lanes, N                          3
Free-flow speed:                            Measured
     FFS or BFFS                            70.0           mi/h
Lane width adjustment, fLW                  0.0            mi/h
Lateral clearance adjustment, fLC           0.0            mi/h
Interchange density adjustment, fID         0.0            mi/h
Number of lanes adjustment, fN              3.0            mi/h
Free-flow speed, FFS                        70.0           mi/h
                                            Urban Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                               899            pc/h/ln
Free-flow speed, FFS                        70.0           mi/h
Average passenger-car speed, S              70.0           mi/h
Number of lanes, N                          3
Density, D                                  12.8           pc/mi/ln
Level of service, LOS                       B

  Overall results are not computed when free-flow speed is less than 55 mph.
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_________________________Operational Analysis__________________________________

Analyst:                 Tom Hiles
Agency or Company:       HDR Inc.
Date Performed:          4/1/2008 4:10:06 PM
Analysis Time Period:    AM
Freeway/Direction:       I-35 Southbound
From/To:                 Waverly Road to Sunflower Road
Jurisdiction:            KDOT
Analysis Year:           2030
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                   1270           veh/h
Peak-hour factor, PHF                       0.90
Peak 15-min volume, v15                     353            v
Trucks and buses                            19             %
Recreational vehicles                       0              %
Terrain type:                               Level
    Grade                                   0.00           %
    Segment length                          0.00           mi
Trucks and buses PCE, ET                    1.5
Recreational vehicle PCE, ER                1.2
Heavy vehicle adjustment, fHV               0.913
Driver population factor, fp                1.00
Flow rate, vp                               773            pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                  12.0           ft
Right-shoulder lateral clearance            6.0            ft
Interchange density                         0.50           interchange/mi
Number of lanes, N                          2
Free-flow speed:                            Measured
     FFS or BFFS                            70.0           mi/h
Lane width adjustment, fLW                  0.0            mi/h
Lateral clearance adjustment, fLC           0.0            mi/h
Interchange density adjustment, fID         0.0            mi/h
Number of lanes adjustment, fN              0.0            mi/h
Free-flow speed, FFS                        70.0           mi/h
                                            Rural Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                               773            pc/h/ln
Free-flow speed, FFS                        70.0           mi/h
Average passenger-car speed, S              70.0           mi/h
Number of lanes, N                          2
Density, D                                  11.0+          pc/mi/ln
Level of service, LOS                       B

  Overall results are not computed when free-flow speed is less than 55 mph.
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2030 Gardner No Action - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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_______Operational Analysis_______

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:10:06 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Northbound
From/To: Edgerton Road to Sunflower Road
Jurisdiction:
Analysis Year: 2030
Description: NEPA Traffic Study

_______Flow Inputs and Adjustments_______

Volume, V	1350	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	375	v
Trucks and buses	21	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.905	
Driver population factor, fp	1.00	
Flow rate, vp	829	pc/h/ln

_______Speed Inputs and Adjustments_______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______LOS and Performance Measures_______

Flow rate, vp	829	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	11.8	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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_______Operational Analysis_______

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:10:06 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Northbound
From/To: Sunflower Road to Waverly Road
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

_______Flow Inputs and Adjustments_______

Volume, V	1540	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	428	v
Trucks and buses	19	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.913	
Driver population factor, fp	1.00	
Flow rate, vp	937	pc/h/ln

_______Speed Inputs and Adjustments_______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______LOS and Performance Measures_______

Flow rate, vp	937	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	13.4	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Gardner No Action - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:10:06 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Waverly Road to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	1960	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	544	v
Trucks and buses	16	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.926	
Driver population factor, fp	1.00	
Flow rate, vp	784	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	1.15	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	3.2	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	784	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	11.2	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:10:06 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Gardner Road to US 56
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	2760	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	767	v
Trucks and buses	12	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.943	
Driver population factor, fp	1.00	
Flow rate, vp	1084	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1084	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	15.5	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Gardner No Action - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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________________________Operational Analysis_________________________________

Analyst:                Tom Hiles
Agency or Company:      HDR Inc.
Date Performed:         4/1/2008 4:10:06 PM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Northbound
From/To:                US 56 to 151st Street
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

________________________Flow Inputs and Adjustments__________________________

Volume, V                                 4200          veh/h
Peak-hour factor, PHF                     0.90
Peak 15-min volume, v15                   1167          v
Trucks and buses                          9             %
Recreational vehicles                     0             %
Terrain type:                             Level
    Grade                                 0.00          %
    Segment length                        0.00          mi
Trucks and buses PCE, ET                  1.5
Recreational vehicle PCE, ER              1.2
Heavy vehicle adjustment, fHV             0.957
Driver population factor, fp              1.00
Flow rate, vp                             1626          pc/h/ln

________________________Speed Inputs and Adjustments__________________________

Lane width                                12.0          ft
Right-shoulder lateral clearance          6.0           ft
Interchange density                       0.50          interchange/mi
Number of lanes, N                        3
Free-flow speed:                          Measured
     FFS or BFFS                          70.0          mi/h
Lane width adjustment, fLW                0.0           mi/h
Lateral clearance adjustment, fLC         0.0           mi/h
Interchange density adjustment, fID       0.0           mi/h
Number of lanes adjustment, fN            3.0           mi/h
Free-flow speed, FFS                      70.0          mi/h
                                          Urban Freeway

________________________LOS and Performance Measures_________________________

Flow rate, vp                             1626          pc/h/ln
Free-flow speed, FFS                      70.0          mi/h
Average passenger-car speed, S            69.3          mi/h
Number of lanes, N                        3
Density, D                                23.5          pc/mi/ln
Level of service, LOS                     C

  Overall results are not computed when free-flow speed is less than 55 mph.
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HCS+: Basic Freeway Segments Release 5.21

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________________________Operational Analysis_________________________________

Analyst:                Tom Hiles
Agency or Company:      HDR Inc.
Date Performed:         4/1/2008 4:10:06 PM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Southbound
From/To:                151Street to US 56
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

________________________Flow Inputs and Adjustments__________________________

Volume, V                                 5460          veh/h
Peak-hour factor, PHF                     0.90
Peak 15-min volume, v15                   1517          v
Trucks and buses                          7             %
Recreational vehicles                     0             %
Terrain type:                             Level
    Grade                                 0.00          %
    Segment length                        0.00          mi
Trucks and buses PCE, ET                  1.5
Recreational vehicle PCE, ER              1.2
Heavy vehicle adjustment, fHV             0.966
Driver population factor, fp              1.00
Flow rate, vp                             2093          pc/h/ln

________________________Speed Inputs and Adjustments__________________________

Lane width                                12.0          ft
Right-shoulder lateral clearance          6.0           ft
Interchange density                       0.50          interchange/mi
Number of lanes, N                        3
Free-flow speed:                          Measured
     FFS or BFFS                          70.0          mi/h
Lane width adjustment, fLW                0.0           mi/h
Lateral clearance adjustment, fLC         0.0           mi/h
Interchange density adjustment, fID       0.0           mi/h
Number of lanes adjustment, fN            3.0           mi/h
Free-flow speed, FFS                      70.0          mi/h
                                          Urban Freeway

________________________LOS and Performance Measures_________________________

Flow rate, vp                             2093          pc/h/ln
Free-flow speed, FFS                      70.0          mi/h
Average passenger-car speed, S            62.9          mi/h
Number of lanes, N                        3
Density, D                                33.3          pc/mi/ln
Level of service, LOS                     D

  Overall results are not computed when free-flow speed is less than 55 mph.
```

2030 Gardner No Action - PM Peak Hour - HCS Freeway Mainline

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Level of service, LOS D

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:10:06 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	US 56 to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	4670	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1297	v
Trucks and buses	8	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.962	
Driver population factor, fp	1.00	
Flow rate, vp	1799	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1799	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	67.9	mi/h
Number of lanes, N	3	
Density, D	26.5	pc/mi/ln

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Level of service, LOS C

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: Fax:
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Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:10:06 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	Gardner Road to Waverly Road
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	3460	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	961	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1346	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	1.15	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	3.2	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1346	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	19.2	pc/mi/ln

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___Operational Analysis___

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Analyst:                Tom Hiles
Agency or Company:      HDR Inc.
Date Performed:         4/1/2008 4:10:06 PM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Southbound
From/To:                Waverly Road to Sunflower Road
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study
```

___Flow Inputs and Adjustments___

Volume, V	3200	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	889	v
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.948	
Driver population factor, fp	1.00	
Flow rate, vp	1876	pc/h/ln

___Speed Inputs and Adjustments___

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

___LOS and Performance Measures___

Flow rate, vp	1876	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	66.9	mi/h
Number of lanes, N	2	
Density, D	28.0	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
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___Operational Analysis___

```
Analyst:                Tom Hiles
Agency or Company:      HDR Inc.
Date Performed:         4/1/2008 4:10:06 PM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Southbound
From/To:                Sunflower Road to Edgerton Road
Jurisdiction:
Analysis Year:          2030
Description:  NEPA Traffic Study
```

___Flow Inputs and Adjustments___

Volume, V	2730	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	758	v
Trucks and buses	12	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.943	
Driver population factor, fp	1.00	
Flow rate, vp	1608	pc/h/ln

___Speed Inputs and Adjustments___

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

___LOS and Performance Measures___

Flow rate, vp	1608	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	69.4	mi/h
Number of lanes, N	2	
Density, D	23.2	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Gardner No Action - AM Peak Hour - HCS Freeway Ramps

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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         2400          vph

_________________________________Off Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            160           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)______________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                      Freeway     Ramp        Adjacent
                                                                 Ramp
Volume, V (vph)                          2400        160                  vph
Peak-hour factor, PHF                    0.90        0.90
Peak 15-min volume, v15                  667         44                   v
Trucks and buses                         9           6                    %
Recreational vehicles                    0           0                    %
Terrain type:                            Level       Rolling
     Grade                               0.00    %   0.00    %            %
     Length                              0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                 1.5*        2.5
Recreational vehicle PCE, ER             1.2*        2.0
Heavy vehicle adjustment, fHV            0.957       0.917
Driver population factor, fP             1.00        1.00
Flow rate, vp                            2787        194                  pcph

_________________________Estimation of V12 Diverge Areas________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2787   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                2787          4800            No
      Fi   F
     v  = v - v            2593          4800            No
      FO   F   R
     v                     194           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                2787          4600                   No
      12                                                                       !
_________________Level of Service Determination (if not F)______________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   21.0    pc/mi/ln
                     R                  12          D
Level of service for ramp-freeway junction areas of influence C

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.445
                                              S
Space mean speed in ramp influence area,     S  = 57.5    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.5    mph
________________________________________________________________________________
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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         2240          vph

__________________________________On Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            680           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)______________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                      Freeway     Ramp        Adjacent
                                                                 Ramp
Volume, V (vph)                          2240        680                  vph
Peak-hour factor, PHF                    0.90        0.90
Peak 15-min volume, v15                  622         189                  v
Trucks and buses                         9           2                    %
Recreational vehicles                    0           0                    %
Terrain type:                            Level       Rolling
     Grade                                       %           %            %
     Length                                      mi          mi           mi
Trucks and buses PCE, ET                 1.5*        2.5
Recreational vehicle PCE, ER             1.2*        2.0
Heavy vehicle adjustment, fHV            0.957       0.971
Driver population factor, fP             1.00        1.00
Flow rate, vp                            2601        778                  pcph

_________________________Estimation of V12 Merge Areas__________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2601   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     3379          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area________________________
                      Actual        Max Desirable          Violation?
     v                2601          4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   26.5    pc/mi/ln
          R                   R           12           A
Level of service for ramp-freeway junction areas of influence  C

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.379
                                              S
Space mean speed in ramp influence area,     S  = 59.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 59.4    mph
________________________________________________________________________________
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2030 Gardner No Action - AM Peak Hour - HCS Freeway Ramps

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Phone: Fax:
E-mail:

Diverge Analysis

Analyst: Tom Hiles
Agency/Co.: HDR Inc.
Date performed: 4/1/2008 4:04:23 PM
Analysis time period: AM
Freeway/Dir of Travel: I-35 Northbound
Junction: 3 Waverly Exit
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	2920	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	260	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	2920		260			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	811		72			v
Trucks and buses	8		2			%
Recreational vehicles	0		0			%
Terrain type:	Level		Rolling			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5*		2.5			
Recreational vehicle PCE, ER	1.2*		2.0			
Heavy vehicle adjustment, fHV	0.962		0.971			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	3374		298			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3374 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3374	4800	No
$v_{FO} = v_F - v_R$	3076	4800	No
v_R	298	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} =		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3374	4600	No !

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ = 26.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.455

Space mean speed in ramp influence area, S_R = 57.3 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 57.3 mph

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Phone: Fax:
E-mail:

Merge Analysis

Analyst: Tom Hiles
Agency/Co.: HDR Inc.
Date performed: 4/1/2008 4:04:23 PM
Analysis time period: AM
Freeway/Dir of Travel: I-35 Northbound
Junction: 4 Waverly Entr
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	70.0	mph
Volume on freeway	2660	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	600	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	2660		600			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	739		167			v
Trucks and buses	8		2			%
Recreational vehicles	0		0			%
Terrain type:	Level		Rolling			
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5*		2.5			
Recreational vehicle PCE, ER	1.2*		2.0			
Heavy vehicle adjustment, fHV	0.962		0.971			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	3074		687			pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.600 Using Equation 1

$v_{12} = v_F (P_{FM})$ = 1844 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3761	7200	No
v_3 or v_{av34}	1230 pc/h	(Equation 25-4 or 25-5)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} =		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1844	4400	No !

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 19.9 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, M_S = 0.314

Space mean speed in ramp influence area, S_R = 61.2 mph

Space mean speed in outer lanes, S_0 = 67.4 mph

Space mean speed for all vehicles, S = 63.1 mph

2030 Gardner No Action - AM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                      Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           3260           vph

________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              420            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         3260        420                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 906         117                  v
Trucks and buses                        7           2                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.966       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3749        481                      pcph

________________________Estimation of V12 Diverge Areas________________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.644   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  2586   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                3749          7200            No
      Fi   F
     v  = v - v            3268          7200            No
      FO   F   R
     v                     481           2000            No
      R
     v     v               1163 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2586          4600                   No
      12                                                                     !
________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   19.3    pc/mi/ln
                        R                 12          D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation_________________________________

Intermediate speed variable,                 D  = 0.471
                                              S
Space mean speed in ramp influence area,     S  = 56.8     mph
                                              R
Space mean speed in outer lanes,             S  = 76.2     mph
                                              0
Space mean speed for all vehicles,           S  = 61.7     mph
_______________________________________________________________________________
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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                      Fax:
E-mail:

________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           2840           vph

_________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              1520           vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2840        1520                 vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 789         422                  v
Trucks and buses                        7           2                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.966       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3266        1740                     pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1959   pc/h
                   12   F   FM

______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     5006          7200            No
      FO
     v     v               1307 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                1959          4400                   No
      12                                                                     !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   28.5    pc/mi/ln
              R                 R          12            A
Level of service for ramp-freeway junction areas of influence  D

______________________________Speed Estimation_________________________________

Intermediate speed variable,                 M  = 0.423
                                              S
Space mean speed in ramp influence area,     S  = 58.2     mph
                                              R
Space mean speed in outer lanes,             S  = 67.1     mph
                                              0
Space mean speed for all vehicles,           S  = 60.3     mph
_______________________________________________________________________________
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                 HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 3
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          4360           vph

________________________________Off Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0           mph
Volume on ramp                             890            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        4360        890                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                1211        247                  v
Trucks and buses                       6           4                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
    Grade                              0.00    %   0.00    %            %
    Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.971       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          4990        1048                 pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.587   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  3362   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                4990          7200            No
      Fi   F
     v  = v - v            3942          7200            No
      FO   F   R
     v                     1048          2000            No
      R
     v     v               1628 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                3362          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density,           D = 4.252 + 0.0086 v  - 0.009  L   =   26.0    pc/mi/ln
                                       R           12      D
Level of service for ramp-freeway junction areas of influence C

____________________________Speed Estimation___________________________________

Intermediate speed variable,                D  = 0.522
                                             S
Space mean speed in ramp influence area,    S  = 55.4    mph
                                             R
Space mean speed in outer lanes,            S  = 74.3    mph
                                             0
Space mean speed for all vehicles,          S  = 60.4    mph
_______________________________________________________________________________
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                 HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               8 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Merge
Number of lanes in freeway                 3
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          5140           vph

_________________________________On Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             550            vph
Length of first accel/decel lane           1000           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        5140        550                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                1428        153                  v
Trucks and buses                       6           2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
    Grade                                      %           %            %
    Length                                     mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.971       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          5882        629                  pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.605   Using Equation  1
                   FM
                  v  = v  (P  ) =  3562   pc/h
                   12   F   FM

______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     6511          7200            No
      FO
     v     v               2320 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                3562          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   31.6    pc/mi/ln
                              R             12          A
Level of service for ramp-freeway junction areas of influence  D

____________________________Speed Estimation___________________________________

Intermediate speed variable,                M  = 0.509
                                             S
Space mean speed in ramp influence area,    S  = 55.8    mph
                                             R
Space mean speed in outer lanes,            S  = 63.3    mph
                                             0
Space mean speed for all vehicles,          S  = 58.2    mph
_______________________________________________________________________________
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2030 Gardner No Action - AM Peak Hour - HCS Freeway Ramps

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                  HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               9 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           3470          vph

__________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              1670          vph
Length of first accel/decel lane            500           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)______________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        3470        1670                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                964         464                    v
Trucks and buses                       6           2                      %
Recreational vehicles                  0           0                      %
Terrain type:                          Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.971       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3971        1911                   pcph

_________________________Estimation of V12 Merge Areas__________________________

                  L   =            (Equation 25-2 or 25-3)
                   EQ
                  P   =    0.591   Using Equation  1
                   FM
                  v  = v  (P  ) =  2349   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     5882          7200            No
      FO
     v     v               1622 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area_______________________
                      Actual        Max Desirable          Violation?
     v                2349          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   34.7    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  D

____________________________Speed Estimation____________________________________

Intermediate speed variable,              M  = 0.562
                                           S
Space mean speed in ramp influence area,  S  = 54.3    mph
                                           R
Space mean speed in outer lanes,          S  = 66.0    mph
                                           0
Space mean speed for all vehicles,        S  = 57.1    mph
________________________________________________________________________________
```

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Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           3480          vph

_________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     2
Free-Flow speed on ramp                     45.0          mph
Volume on ramp                              1610          vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane           500           ft

________________________Adjacent Ramp Data (if one exists)______________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        3480        1610                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                967         447                    v
Trucks and buses                       9           3                      %
Recreational vehicles                  0           0                      %
Terrain type:                          Level       Rolling
     Grade                             0.00   %    0.00   %           %
     Length                            0.00   mi   0.00   mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.957       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          4041        1869                   pcph

_________________________Estimation of V12 Diverge Areas________________________

                  L   =            (Equation 25-8 or 25-9)
                   EQ
                  P   =    0.450   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2846   pc/h
                   12   R     F   R  FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                4041          7200            No
      Fi   F
     v  = v - v            2172          7200            No
      FO   F   R
     v                     1869          4100            No
      R
     v     v               1195 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                2846          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)______________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   9.8     pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence A

____________________________Speed Estimation____________________________________

Intermediate speed variable,              D  = 0.466
                                           S
Space mean speed in ramp influence area,  S  = 56.9    mph
                                           R
Space mean speed in outer lanes,          S  = 76.0    mph
                                           0
Space mean speed for all vehicles,        S  = 61.5    mph
________________________________________________________________________________
```

2030 Gardner No Action - AM Peak Hour - HCS Freeway Ramps

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                HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Merge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data________________________________

Type of analysis                          Merge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0           mph
Volume on freeway                         1870           vph

_________________________________On Ramp Data________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0           mph
Volume on ramp                            410            vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

___________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1870        410                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                519         114                  v
Trucks and buses                       9           7                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                    %           %            %
     Length                                   mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.957       0.905
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2171        503                  pcph

_________________________Estimation of V12 Merge Areas_______________________

                  L  =           (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1302   pc/h
                   12   F   FM

________________________________Capacity Checks______________________________

                           Actual        Maximum         LOS F?
     v                     2674          7200            No
      FO
     v     v               869  pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area___________________
                      Actual        Max Desirable          Violation?
     v                1302          4400                   No
      12                                                                    !
________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   14.3    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

____________________________Speed Estimation________________________________

Intermediate speed variable,              M  = 0.289
                                           S
Space mean speed in ramp influence area,  S  = 61.9    mph
                                           R
Space mean speed in outer lanes,          S  = 68.7    mph
                                           0
Space mean speed for all vehicles,        S  = 64.0    mph
_____________________________________________________________________________
```

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Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis_____________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data________________________________

Type of analysis                          Diverge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0           mph
Volume on freeway                         2280           vph

________________________________Off Ramp Data________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0           mph
Volume on ramp                            830            vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

___________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        2280        830                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                633         231                  v
Trucks and buses                       13          7                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00   %    0.00   %            %
     Length                            0.00   mi   0.00   mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.939       0.905
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2698        1019                 pcph

_________________________Estimation of V12 Diverge Areas_____________________

                  L  =           (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.646   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  2103   pc/h
                   12   R      F   R   FD

________________________________Capacity Checks______________________________

                           Actual        Maximum         LOS F?
     v  = v                2698          7200            No
      Fi   F
     v  = v - v            1679          7200            No
      FO   F   R
     v                     1019          2000            No
      R
     v     v               595  pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

_____________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable          Violation?
     v                2103          4600                   No
      12                                                                    !
________________Level of Service Determination (if not F)___________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   15.1    pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation________________________________

Intermediate speed variable,              D  = 0.520
                                           S
Space mean speed in ramp influence area,  S  = 55.4    mph
                                           R
Space mean speed in outer lanes,          S  = 76.8    mph
                                           0
Space mean speed for all vehicles,        S  = 59.1    mph
_____________________________________________________________________________
```

2030 Gardner No Action - AM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                          Merge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1450          vph

__________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            180           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1450        180                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               403         50                    v
Trucks and buses                      13          3                     %
Recreational vehicles                 0           0                     %
Terrain type:                         Level       Rolling
     Grade                                  %           %           %
     Length                                 mi          mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.939       0.957
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1716        209                   pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1029   pc/h
                   12   F   FM

______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     1925          7200            No
      FO
     v     v               687  pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                1029          4400                  No
      12                                                                      !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   10.0+   pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

____________________________Speed Estimation___________________________________

Intermediate speed variable,                M  = 0.278
                                             S
Space mean speed in ramp influence area,    S  = 62.2    mph
                                             R
Space mean speed in outer lanes,            S  = 69.3    mph
                                             0
Space mean speed for all vehicles,          S  = 64.6    mph
_______________________________________________________________________________
```

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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               14 Waverly Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                          Diverge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1630          vph

_________________________________Off Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            470           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1630        470                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               453         131                   v
Trucks and buses                      15          2                     %
Recreational vehicles                 0           0                     %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %             %
     Length                           0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.930       0.971
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1947        538                   pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.687   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  1505   pc/h
                   12   R     F   R  FD

______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                1947          7200            No
      Fi   F
     v  = v - v            1409          7200            No
      FO   F   R
     v                     538           2000            No
      R
     v     v               442  pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable         Violation?
     v                1505          4600                  No
      12                                                                      !
________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   10.0-   pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence A

____________________________Speed Estimation___________________________________

Intermediate speed variable,                D  = 0.476
                                             S
Space mean speed in ramp influence area,    S  = 56.7    mph
                                             R
Space mean speed in outer lanes,            S  = 76.8    mph
                                             0
Space mean speed for all vehicles,          S  = 60.2    mph
_______________________________________________________________________________
```

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                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Merge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               15 Waverly Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1160          vph

_________________________________On Ramp Data_______________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              110           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1160        110                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 322         31                   v
Trucks and buses                        15          2                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
    Grade                                       %           %           %
    Length                                      mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.930       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1386        126                   pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1386   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1512          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1386          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   12.2    pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  B

____________________________Speed Estimation___________________________________

Intermediate speed variable,                  M  = 0.283
                                               S
Space mean speed in ramp influence area,      S  = 62.1    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 62.1    mph
_______________________________________________________________________________
```

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                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis____________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               16 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1270          vph

________________________________Off Ramp Data_______________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              170           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1270        170                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 353         47                   v
Trucks and buses                        19          4                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
    Grade                               0.00    %   0.00    %           %
    Length                              0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.913       0.943
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1545        200                   pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1545   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1545          4800            No
      Fi   F
     v  = v - v            1345          4800            No
      FO   F   R
     v                     200           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable          Violation?
     v                1545          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   10.3    pc/mi/ln
                                         R           12        D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation___________________________________

Intermediate speed variable,                  D  = 0.446
                                               S
Space mean speed in ramp influence area,      S  = 57.5    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 57.5    mph
_______________________________________________________________________________
```

2030 Gardner No Action - AM Peak Hour - HCS Freeway Ramps

HCS+: Ramps and Ramp Junctions Release 5.21

Phone: Fax:
E-mail:

Merge Analysis

Analyst: Tom Hiles
Agency/Co.: HDR Inc.
Date performed: 4/1/2008 4:04:23 PM
Analysis time period: AM
Freeway/Dir of Travel: I-35 Southbound
Junction: 17 Sunflower Entr
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1100	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	90	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1100	90		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	306	25		v
Trucks and buses	19	2		%
Recreational vehicles	0	0		%
Terrain type:	Level	Rolling		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5*	2.5		
Recreational vehicle PCE, ER	1.2*	2.0		
Heavy vehicle adjustment, fHV	0.913	0.971		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	1338	103		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1338 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1441	4800	No
$v_{3\ or\ av34}$	0 pc/h	(Equation 25-4 or 25-5)	
Is $v_{3\ or\ av34}$ > 2700 pc/h?		No	
Is $v_{3\ or\ av34}$ > 1.5 v_{12}/2		No	
If yes, v_{12A} =		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1338	4400	No

!

Level of Service Determination (if not F)

Density, $D = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 11.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, M_S = 0.281

Space mean speed in ramp influence area, S_R = 62.1 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 62.1 mph

```
                 HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1350          vph

________________________________Off Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            90            vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1350        90                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               375         25                   v
Trucks and buses                      21          2                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %            %
     Length                           0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.905       0.971
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1658        103                  pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1658   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum        LOS F?
     v  = v                1658          4800           No
      Fi   F
     v  = v - v            1555          4800           No
      FO   F   R
     v                     103           2000           No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual       Max Desirable         Violation?
     v                1658         4600                  No
      12                                                                    !
_________________Level of Service Determination (if not F)____________________

Density,            D = 4.252 + 0.0086 v  - 0.009  L   =   11.3    pc/mi/ln
                     R                  12          D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation_________________________________

Intermediate speed variable,                 D  = 0.437
                                              S
Space mean speed in ramp influence area,     S  = 57.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.8    mph
_______________________________________________________________________________
```

```
                 HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1260          vph

_________________________________On Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            280           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1260        280                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               350         78                   v
Trucks and buses                      21          4                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                                    %           %            %
     Length                                   mi          mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.905       0.943
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1547        330                  pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1547   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum        LOS F?
     v                     1877          4800           No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual       Max Desirable         Violation?
     v                1547         4400                  No
      12                                                                    !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   14.9    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation_________________________________

Intermediate speed variable,                 M  = 0.290
                                              S
Space mean speed in ramp influence area,     S  = 61.9    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.9    mph
_______________________________________________________________________________
```

2030 Gardner No Action - PM Peak Hour - HCS Freeway Ramps

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                  HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Waverly Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1540           vph

________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              100            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1540        100                 vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 428         28                  v
Trucks and buses                        19          2                   %
Recreational vehicles                   0           0                   %
Terrain type:                           Level       Rolling
    Grade                               0.00    %   0.00     %          %
    Length                              0.00    mi  0.00     mi         mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.913       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1874        114                 pcph

________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1874   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1874          4800            No
      Fi   F
     v  = v - v            1760          4800            No
      FO   F   R
     v                     114           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                1874          4600                  No
      12                                                                      !
________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   13.2    pc/mi/ln
                                          R             12      D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.438
                                              S
Space mean speed in ramp influence area,     S  = 57.7    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.7    mph
______________________________________________________________________________
```

```
                  HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
E-mail:

________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Waverly Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1440           vph

_________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              520            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1440        520                 vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 400         144                 v
Trucks and buses                        19          2                   %
Recreational vehicles                   0           0                   %
Terrain type:                           Level       Rolling
    Grade                                       %            %          %
    Length                                      mi           mi         mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.913       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1752        595                 pcph

________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1051   pc/h
                   12   F   FM

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2347          7200            No
      FO
     v     v               701  pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable         Violation?
     v                1051          4400                  No
      12                                                                      !
________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   13.0    pc/mi/ln
          R                  R            12            A
Level of service for ramp-freeway junction areas of influence  B

____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.285
                                              S
Space mean speed in ramp influence area,     S  = 62.0    mph
                                              R
Space mean speed in outer lanes,             S  = 69.3    mph
                                              0
Space mean speed for all vehicles,           S  = 64.0    mph
______________________________________________________________________________
```

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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 3
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1960           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0           mph
Volume on ramp                             210            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1960        210                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                544         58                    v
Trucks and buses                       16          5                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %             %
     Length                            0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.926       0.930
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2352        251                   pcph

_________________________Estimation of V12 Diverge Areas_________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.690   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  1700   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks___________________________________

                           Actual        Maximum        LOS F?
     v  = v                2352          7200           No
      Fi   F
     v  = v - v            2101          7200           No
      FO   F   R
     v                     251           2000           No
      R
     v     v               652  pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_______________________
                      Actual        Max Desirable          Violation?
     v                1700          4600                   No
      12                                                                        !
_________________Level of Service Determination (if not F)_______________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   11.7    pc/mi/ln
                         R                12          D
Level of service for ramp-freeway junction areas of influence B

_______________________________Speed Estimation__________________________________

Intermediate speed variable,               D  = 0.451
                                            S
Space mean speed in ramp influence area,   S  = 57.4    mph
                                            R
Space mean speed in outer lanes,           S  = 76.8    mph
                                            0
Space mean speed for all vehicles,         S  = 61.7    mph
_________________________________________________________________________________
```

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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                           Merge
Number of lanes in freeway                 3
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1750           vph

__________________________________On Ramp Data___________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             1010           vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1750        1010                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                486         281                   v
Trucks and buses                       16          4                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                                     %           %             %
     Length                                    mi          mi            mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.926       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2100        1190                  pcph

_________________________Estimation of V12 Merge Areas___________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1260   pc/h
                   12   F   FM

_______________________________Capacity Checks___________________________________

                           Actual        Maximum        LOS F?
     v                     3290          7200           No
      FO
     v     v               840  pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34        12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_______________________
                      Actual        Max Desirable          Violation?
     v                1260          4400                   No
      12                                                                        !
_________________Level of Service Determination (if not F)_______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   19.0    pc/mi/ln
          R                   R          12            A
Level of service for ramp-freeway junction areas of influence  B

_______________________________Speed Estimation__________________________________

Intermediate speed variable,               M  = 0.310
                                            S
Space mean speed in ramp influence area,   S  = 61.3    mph
                                            R
Space mean speed in outer lanes,           S  = 68.8    mph
                                            0
Space mean speed for all vehicles,         S  = 63.1    mph
_________________________________________________________________________________
```

2030 Gardner No Action - PM Peak Hour - HCS Freeway Ramps

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                  HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2760          vph

_________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              490           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2760        490                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 767         136                  v
Trucks and buses                        12          8                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.943       0.893
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3251        610                  pcph

_________________________Estimation of V12 Diverge Areas_________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.651   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  2328   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks___________________________________

                            Actual        Maximum         LOS F?
     v  = v                 3251          7200            No
      Fi   F
     v  = v - v             2641          7200            No
      FO   F   R
     v                      610           2000            No
      R
     v     v                923  pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?            No
      3 or  av34
Is   v     v      > 1.5 v  /2             No
      3 or  av34         12
If yes, v    =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_______________________
                       Actual        Max Desirable          Violation?
     v                 2328          4600                   No
      12                                                                         !
_________________Level of Service Determination (if not F)_______________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   17.1    pc/mi/ln
                                         R             12       D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation___________________________________

Intermediate speed variable,                  D  = 0.483
                                               S
Space mean speed in ramp influence area,      S  = 56.5    mph
                                               R
Space mean speed in outer lanes,              S  = 76.8    mph
                                               0
Space mean speed for all vehicles,            S  = 61.1    mph
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                  HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               8 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           3620          vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              580           vph
Length of first accel/decel lane            1000          ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         3620        580                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 1006        161                  v
Trucks and buses                        12          3                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.943       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           4264        673                  pcph

_________________________Estimation of V12 Merge Areas___________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.605   Using Equation  1
                   FM
                  v  = v  (P  ) =  2582   pc/h
                   12   F   FM

_______________________________Capacity Checks___________________________________

                            Actual        Maximum         LOS F?
     v                      4937          7200            No
      FO
     v     v                1682 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?            No
      3 or  av34
Is   v     v      > 1.5 v  /2             No
      3 or  av34         12
If yes, v    =                            (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area________________________
                       Actual        Max Desirable          Violation?
     v                 2582          4400                   No
      12                                                                         !
_________________Level of Service Determination (if not F)_______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   24.3    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  C

______________________________Speed Estimation___________________________________

Intermediate speed variable,                  M  = 0.352
                                               S
Space mean speed in ramp influence area,      S  = 60.1    mph
                                               R
Space mean speed in outer lanes,              S  = 65.7    mph
                                               0
Space mean speed for all vehicles,            S  = 61.9    mph
_________________________________________________________________________________
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2030 Gardner No Action - PM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Merge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               9 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data________________________________

Type of analysis                          Merge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0          mph
Volume on freeway                         2270          vph

_________________________________On Ramp Data________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            1350          vph
Length of first accel/decel lane          500           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       2270        1350                 vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               631         375                  v
Trucks and buses                      12          3                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                                   %           %           %
     Length                                  mi          mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.943       0.957
Driver population factor, fP          1.00        1.00
Flow rate, vp                         2674        1568                    pcph

_________________________Estimation of V12 Merge Areas_______________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.591   Using Equation  1
                   FM
                  v  = v  (P  ) =  1582   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     4242          7200            No
      FO
     v     v               1092 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area___________________
                      Actual        Max Desirable           Violation?
     v                1582          4400                    No
      12                                                                     !
________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   26.2    pc/mi/ln
          R                  R            12            A
Level of service for ramp-freeway junction areas of influence  C

____________________________Speed Estimation________________________________

Intermediate speed variable,              M  = 0.377
                                           S
Space mean speed in ramp influence area,  S  = 59.4    mph
                                           R
Space mean speed in outer lanes,          S  = 67.9    mph
                                           0
Space mean speed for all vehicles,        S  = 61.4    mph
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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis_____________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data________________________________

Type of analysis                          Diverge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0          mph
Volume on freeway                         5460          vph

________________________________Off Ramp Data________________________________

Side of freeway                           Right
Number of lanes in ramp                   2
Free-Flow speed on ramp                   45.0          mph
Volume on ramp                            1730          vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane         500           ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       5460        1730                 vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               1517        481                  v
Trucks and buses                      7           2                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                            0.00   %    0.00   %           %
     Length                           0.00   mi   0.00   mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.966       0.971
Driver population factor, fP          1.00        1.00
Flow rate, vp                         6279        1980                    pcph

_________________________Estimation of V12 Diverge Areas_____________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.450   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  3915   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v  = v                6279          7200            No
      Fi   F
     v  = v - v            4299          7200            No
      FO   F   R
     v                     1980          4100            No
      R
     v     v               2364 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable           Violation?
     v                3915          4600                    No
      12                                                                     !
________________Level of Service Determination (if not F)___________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   19.0    pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation________________________________

Intermediate speed variable,              D  = 0.476
                                           S
Space mean speed in ramp influence area,  S  = 56.7    mph
                                           R
Space mean speed in outer lanes,          S  = 71.5    mph
                                           0
Space mean speed for all vehicles,        S  = 61.5    mph
_____________________________________________________________________________
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2030 Gardner No Action - PM Peak Hour - HCS Freeway Ramps

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                HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                Fax:
E-mail:

________________________________Merge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                          Merge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0          mph
Volume on freeway                         3730          vph

_________________________________On Ramp Data_______________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            940           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions________________

Junction Components                   Freeway    Ramp       Adjacent
                                                            Ramp
Volume, V (vph)                       3730       940                 vph
Peak-hour factor, PHF                 0.90       0.90
Peak 15-min volume, v15               1036       261                 v
Trucks and buses                      7          3                   %
Recreational vehicles                 0          0                   %
Terrain type:                         Level      Rolling
    Grade                                   %          %          %
    Length                                  mi         mi         mi
Trucks and buses PCE, ET              1.5*       2.5
Recreational vehicle PCE, ER          1.2*       2.0
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Heavy vehicle adjustment, fHV         0.966      0.957
Driver population factor, fP          1.00       1.00
Flow rate, vp                         4289       1091                 pcph

_________________________Estimation of V12 Merge Areas______________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  2573   pc/h
                   12   F   FM

_______________________________Capacity Checks______________________________

                           Actual        Maximum        LOS F?
     v                     5380          7200           No
      FO
     v     v               1716 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area__________________
                      Actual        Max Desirable         Violation?
     v                2573          4400                  No
      12                                                               !
_________________Level of Service Determination (if not F)__________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   28.5    pc/mi/ln
          R                    R           12            A
Level of service for ramp-freeway junction areas of influence  D

_____________________________Speed Estimation_______________________________

Intermediate speed variable,               M  = 0.417
                                            S
Space mean speed in ramp influence area,   S  = 58.3    mph
                                            R
Space mean speed in outer lanes,           S  = 65.6    mph
                                            0
Space mean speed for all vehicles,         S  = 60.5    mph
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                HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                Fax:
E-mail:

________________________________Diverge Analysis____________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                          Diverge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0          mph
Volume on freeway                         4670          vph

________________________________Off Ramp Data_______________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            1610          vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions________________

Junction Components                   Freeway    Ramp       Adjacent
                                                            Ramp
Volume, V (vph)                       4670       1610                vph
Peak-hour factor, PHF                 0.90       0.90
Peak 15-min volume, v15               1297       447                 v
Trucks and buses                      8          3                   %
Recreational vehicles                 0          0                   %
Terrain type:                         Level      Rolling
    Grade                             0.00    %  0.00   %            %
    Length                            0.00   mi  0.00   mi           mi
Trucks and buses PCE, ET              1.5*       2.5
Recreational vehicle PCE, ER          1.2*       2.0
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Heavy vehicle adjustment, fHV         0.962      0.957
Driver population factor, fP          1.00       1.00
Flow rate, vp                         5396       1869                 pcph

_________________________Estimation of V12 Diverge Areas____________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.539   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  3770   pc/h
                   12   R      F   R   FD

_______________________________Capacity Checks______________________________

                           Actual        Maximum        LOS F?
     v  = v                5396          7200           No
      Fi   F
     v  = v - v            3527          7200           No
      FO   F   R
     v                     1869          2000           No
      R
     v     v               1626 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area__________________
                      Actual        Max Desirable         Violation?
     v                3770          4600                  No
      12                                                               !
_________________Level of Service Determination (if not F)__________________

Density,                 D = 4.252 + 0.0086 v  - 0.009  L   =   29.5    pc/mi/ln
                          R                  12          D
Level of service for ramp-freeway junction areas of influence D

_____________________________Speed Estimation_______________________________

Intermediate speed variable,               D  = 0.596
                                            S
Space mean speed in ramp influence area,   S  = 53.3    mph
                                            R
Space mean speed in outer lanes,           S  = 74.3    mph
                                            0
Space mean speed for all vehicles,         S  = 58.3    mph
____________________________________________________________________________
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2030 Gardner No Action - PM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                           Merge
Number of lanes in freeway                 3
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          3060          vph

__________________________________On Ramp Data___________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0          mph
Volume on ramp                             400           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        3060        400                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                850         111                   v
Trucks and buses                       8           4                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.962       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3536        471                       pcph

_________________________Estimation of V12 Merge Areas___________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  2121   pc/h
                   12   F   FM

_______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v                     4007          7200            No
      FO
     v     v               1415 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2121          4400                   No
      12                                                                   !
_________________Level of Service Determination (if not F)______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   20.5    pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  C

________________________________Speed Estimation__________________________________

Intermediate speed variable,                M  = 0.317
                                             S
Space mean speed in ramp influence area,    S  = 61.1    mph
                                             R
Space mean speed in outer lanes,            S  = 66.7    mph
                                             0
Space mean speed for all vehicles,          S  = 63.0    mph
__________________________________________________________________________________
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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               14 Waverly Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 3
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          3460          vph

_________________________________Off Ramp Data___________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0          mph
Volume on ramp                             610           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        3460        610                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                961         169                   v
Trucks and buses                       10          2                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.952       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          4037        698                       pcph

_________________________Estimation of V12 Diverge Areas_________________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.627   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  2791   pc/h
                   12   R      F   R   FD

_______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v  = v                4037          7200            No
      Fi   F
     v  = v - v            3339          7200            No
      FO   F   R
     v                     698           2000            No
      R
     v     v               1246 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

_____________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2791          4600                   No
      12                                                                   !
_________________Level of Service Determination (if not F)______________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   21.1    pc/mi/ln
                        R                 12          D
Level of service for ramp-freeway junction areas of influence C

________________________________Speed Estimation__________________________________

Intermediate speed variable,                D  = 0.491
                                             S
Space mean speed in ramp influence area,    S  = 56.3    mph
                                             R
Space mean speed in outer lanes,            S  = 75.8    mph
                                             0
Space mean speed for all vehicles,          S  = 61.1    mph
__________________________________________________________________________________
```

2030 Gardner No Action - PM Peak Hour - HCS Freeway Ramps

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                 HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               15 Waverly Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          2850          vph

_________________________________On Ramp Data_________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0          mph
Volume on ramp                             350           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

___________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        2850        350                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                792         97                   v
Trucks and buses                       10          2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.952       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3325        401                    pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  3325   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v                     3726          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                3325          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   29.3    pc/mi/ln
          R                 R           12             A
Level of service for ramp-freeway junction areas of influence  D

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                M  = 0.427
                                             S
Space mean speed in ramp influence area,    S  = 58.0    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 58.0    mph
_______________________________________________________________________________
```

```
                 HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               16 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          3200          vph

________________________________Off Ramp Data_________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0          mph
Volume on ramp                             660           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

___________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        3200        660                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                889         183                  v
Trucks and buses                       11          2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.948       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3751        755                    pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  3751   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v  = v                3751          4800            No
      Fi   F
     v  = v - v            2996          4800            No
      FO   F   R
     v                     755           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                3751          4600                   No
      12                                                                     !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =    29.3    pc/mi/ln
                       R                 12          D
Level of service for ramp-freeway junction areas of influence D

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                D  = 0.496
                                             S
Space mean speed in ramp influence area,    S  = 56.1    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 56.1    mph
_______________________________________________________________________________
```

2030 Gardner No Action - PM Peak Hour - HCS Freeway Ramps

```
            HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                  Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               17 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2540          vph

__________________________________On Ramp Data________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              190           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        2540        190                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                706         53                    v
Trucks and buses                       11          4                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                                     %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.948       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2977        224                   pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2977   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v                     3201          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                2977          4400                  No
      12                                                                    !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   25.3    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                 M  = 0.361
                                              S
Space mean speed in ramp influence area,     S  = 59.9    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 59.9    mph
______________________________________________________________________________
```

HCS+: Basic Freeway Segments Release 5.21

Level of service, LOS C

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: Fax:
E-mail:

Operational Analysis

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:12:12 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: Edgerton Road to Sunflower Road
Jurisdiction:
Analysis Year: 2030
Description: NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	2410	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	669	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1399	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	1399	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	20.0	pc/mi/ln

HCS+: Basic Freeway Segments Release 5.21

Level of service, LOS C

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: Fax:
E-mail:

Operational Analysis

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:12:12 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: Sunflower Road to Waverly Road
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	2930	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	814	v
Trucks and buses	8	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.962	
Driver population factor, fp	1.00	
Flow rate, vp	1693	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	1693	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	68.9	mi/h
Number of lanes, N	2	
Density, D	24.6	pc/mi/ln

2030 Gardner IMF Operations - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

______Operational Analysis______

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:12:12 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Waverly Road to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

______Flow Inputs and Adjustments______

Volume, V	3400	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	944	v
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.948	
Driver population factor, fp	1.00	
Flow rate, vp	1329	pc/h/ln

______Speed Inputs and Adjustments______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	1.15	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	3.2	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

______LOS and Performance Measures______

Flow rate, vp	1329	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	19.0	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

______Operational Analysis______

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:12:12 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Gardner Road to US 56
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

______Flow Inputs and Adjustments______

Volume, V	4510	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1253	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1746	pc/h/ln

______Speed Inputs and Adjustments______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

______LOS and Performance Measures______

Flow rate, vp	1746	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	68.4	mi/h
Number of lanes, N	3	
Density, D	25.5	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Gardner IMF Operations - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Level of service, LOS E

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:12:12 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: US 56 to 151st Street
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	5780	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1606	v
Trucks and buses	7	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.966	
Driver population factor, fp	1.00	
Flow rate, vp	2216	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	2216	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	59.6	mi/h
Number of lanes, N	3	
Density, D	37.2	pc/mi/ln

HCS+: Basic Freeway Segments Release 5.21

Level of service, LOS C

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:12:12 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Southbound
From/To: 151Street to US 56
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	3590	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	997	v
Trucks and buses	12	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.943	
Driver population factor, fp	1.00	
Flow rate, vp	1409	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	1409	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	20.1	pc/mi/ln

2030 Gardner IMF Operations - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_______Operational Analysis_______

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:12:12 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	US 56 to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2030

Description: NEPA Traffic Study

_______Flow Inputs and Adjustments_______

Volume, V	2430	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	675	v
Trucks and buses	17	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.922	
Driver population factor, fp	1.00	
Flow rate, vp	977	pc/h/ln

_______Speed Inputs and Adjustments_______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_______LOS and Performance Measures_______

Flow rate, vp	977	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	14.0	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_______Operational Analysis_______

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:12:12 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	Gardner Road to Waverly Road
Jurisdiction:	KDOT
Analysis Year:	2030

Description: NEPA Traffic Study

_______Flow Inputs and Adjustments_______

Volume, V	1740	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	483	v
Trucks and buses	20	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.909	
Driver population factor, fp	1.00	
Flow rate, vp	709	pc/h/ln

_______Speed Inputs and Adjustments_______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	1.15	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	3.2	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_______LOS and Performance Measures_______

Flow rate, vp	709	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	10.1	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Gardner IMF Operations - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:12:12 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Southbound
From/To: Waverly Road to Sunflower Road
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	1280	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	356	v
Trucks and buses	19	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.913	
Driver population factor, fp	1.00	
Flow rate, vp	779	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	779	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	11.1	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:12:12 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Southbound
From/To: Sunflower Road to Edgerton Road
Jurisdiction:
Analysis Year: 2030
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	1200	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	333	v
Trucks and buses	20	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.909	
Driver population factor, fp	1.00	
Flow rate, vp	733	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	733	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	10.5	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Gardner IMF Operations - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Level of service, LOS B

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: Fax:
E-mail:

_______________________Operational Analysis________________________________

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:12:12 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Northbound
From/To: Edgerton Road to Sunflower Road
Jurisdiction:
Analysis Year: 2030
Description: NEPA Traffic Study

_______________________Flow Inputs and Adjustments_________________________

Volume, V	1360	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	378	v
Trucks and buses	23	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.897	
Driver population factor, fp	1.00	
Flow rate, vp	842	pc/h/ln

_______________________Speed Inputs and Adjustments________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______________________LOS and Performance Measures________________________

Flow rate, vp	842	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	12.0	pc/mi/ln

HCS+: Basic Freeway Segments Release 5.21

Level of service, LOS B

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: Fax:
E-mail:

_______________________Operational Analysis________________________________

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:12:12 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Northbound
From/To: Sunflower Road to Waverly Road
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

_______________________Flow Inputs and Adjustments_________________________

Volume, V	1550	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	431	v
Trucks and buses	12	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.943	
Driver population factor, fp	1.00	
Flow rate, vp	913	pc/h/ln

_______________________Speed Inputs and Adjustments________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______________________LOS and Performance Measures________________________

Flow rate, vp	913	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	13.0	pc/mi/ln

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:12:12 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Waverly Road to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	2100	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	583	v
Trucks and buses	15	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.930	
Driver population factor, fp	1.00	
Flow rate, vp	836	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	1.15	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	3.2	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	836	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	11.9	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:12:12 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Gardner Road to US 56
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	2910	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	808	v
Trucks and buses	12	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.943	
Driver population factor, fp	1.00	
Flow rate, vp	1142	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1142	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	16.3	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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E-mail:

Operational Analysis

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:12:12 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Northbound
From/To: US 56 to 151st Street
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	4320	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1200	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1672	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1672	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	69.0	mi/h
Number of lanes, N	3	
Density, D	24.2	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:12:12 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: 151Street to US 56
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	5610	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1558	v
Trucks and buses	7	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.966	
Driver population factor, fp	1.00	
Flow rate, vp	2150	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2150	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	61.5	mi/h
Number of lanes, N	3	
Density, D	35.0-	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Gardner IMF Operations - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:12:12 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	US 56 to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	4810	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1336	v
Trucks and buses	8	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.962	
Driver population factor, fp	1.00	
Flow rate, vp	1853	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1853	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	67.2	mi/h
Number of lanes, N	3	
Density, D	27.6	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:12:12 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	Gardner Road to Waverly Road
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	3680	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1022	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1431	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	1.15	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	3.2	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1431	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	69.9	mi/h
Number of lanes, N	3	
Density, D	20.5	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Gardner IMF Operations - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Level of service, LOS D

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: Fax:
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_________________________Operational Analysis__________________________________

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:12:12 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: Waverly Road to Sunflower Road
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V	3200	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	889	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1831	pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_________________________LOS and Performance Measures__________________________

Flow rate, vp	1831	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	67.5	mi/h
Number of lanes, N	2	
Density, D	27.1	pc/mi/ln

HCS+: Basic Freeway Segments Release 5.21

Level of service, LOS C

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: Fax:
E-mail:

_________________________Operational Analysis__________________________________

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:12:12 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: Sunflower Road to Edgerton Road
Jurisdiction:
Analysis Year: 2030
Description: NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V	2730	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	758	v
Trucks and buses	13	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.939	
Driver population factor, fp	1.00	
Flow rate, vp	1615	pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_________________________LOS and Performance Measures__________________________

Flow rate, vp	1615	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	69.4	mi/h
Number of lanes, N	2	
Density, D	23.3	pc/mi/ln

2030 Gardner IMF Operations - AM Peak Hour - HCS Freeway Ramps

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                   HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2410          vph

________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              160           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2410        160                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 669         44                   v
Trucks and buses                        9           6                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.957       0.917
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2798        194                  pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2798   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                2798          4800            No
      Fi   F
     v  = v - v            2604          4800            No
      FO   F   R
     v                     194           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2798          4600                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   21.1    pc/mi/ln
                      R                 12          D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                  D  = 0.445
                                               S
Space mean speed in ramp influence area,      S  = 57.5    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 57.5    mph
_______________________________________________________________________________
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                   HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2250          vph

_________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              680           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2250        680                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 625         189                  v
Trucks and buses                        9           2                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.957       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2613        778                  pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2613   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     3391          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2613          4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   26.6    pc/mi/ln
          R                   R          12           A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                  M  = 0.381
                                               S
Space mean speed in ramp influence area,      S  = 59.3    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 59.3    mph
_______________________________________________________________________________
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2030 Gardner IMF Operations - AM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Waverly Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2930          vph

_________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              300           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        2930        300                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                814         83                   v
Trucks and buses                       8           3                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.962       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3386        348                   pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  3386   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                3386          4800            No
      Fi   F
     v  = v - v            3038          4800            No
      FO   F   R
     v                     348           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                3386          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   26.2    pc/mi/ln
                                         R            12         D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                   D  = 0.459
                                                S
Space mean speed in ramp influence area,       S  = 57.1    mph
                                                R
Space mean speed in outer lanes,               S  =  N/A    mph
                                                0
Space mean speed for all vehicles,             S  = 57.1    mph
________________________________________________________________________________
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Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Waverly Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2630          vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              770           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        2630        770                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                731         214                  v
Trucks and buses                       8           22                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.962       0.752
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3039        1138                  pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1823   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     4177          7200            No
      FO
     v     v               1216 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1823          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   23.0    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                   M  = 0.340
                                                S
Space mean speed in ramp influence area,       S  = 60.5    mph
                                                R
Space mean speed in outer lanes,               S  = 67.4    mph
                                                0
Space mean speed for all vehicles,             S  = 62.3    mph
________________________________________________________________________________
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2030 Gardner IMF Operations - AM Peak Hour - HCS Freeway Ramps

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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                          Diverge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0           mph
Volume on freeway                         3400           vph

________________________________Off Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0           mph
Volume on ramp                            410            vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         3400        410                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 944         114                  v
Trucks and buses                        11          2                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.948       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3986        469                  pcph

________________________Estimation of V12 Diverge Areas________________________

                 L  =            (Equation 25-8 or 25-9)
                  EQ
                 P  =    0.639   Using Equation  5
                  FD
                 v  = v  + (v - v ) P  =  2716   pc/h
                  12   R     F   R   FD

______________________________Capacity Checks__________________________________

                          Actual        Maximum         LOS F?
     v  = v               3986          7200            No
      Fi   F
     v  = v - v           3517          7200            No
      FO   F   R
     v                    469           2000            No
      R
     v     v              1270 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?          No
      3 or  av34
Is   v     v      > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                          (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                     Actual        Max Desirable          Violation?
     v               2716          4600                   No
      12                                                                     !
________________Level of Service Determination (if not F)______________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   20.4    pc/mi/ln
                                  R              12      D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.470
                                              S
Space mean speed in ramp influence area,     S  = 56.8    mph
                                              R
Space mean speed in outer lanes,             S  = 75.7    mph
                                              0
Space mean speed for all vehicles,           S  = 61.7    mph
_______________________________________________________________________________
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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                          Merge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0           mph
Volume on freeway                         2990           vph

_________________________________On Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0           mph
Volume on ramp                            1520           vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2990        1520                 vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 831         422                  v
Trucks and buses                        11          2                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.948       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3505        1740                 pcph

________________________Estimation of V12 Merge Areas__________________________

                 L  =            (Equation 25-2 or 25-3)
                  EQ
                 P  =    0.600   Using Equation  1
                  FM
                 v  = v  (P  ) =  2103   pc/h
                  12   F   FM

______________________________Capacity Checks__________________________________

                          Actual        Maximum         LOS F?
     v                    5245          7200            No
      FO
     v     v              1402 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?          No
      3 or  av34
Is   v     v      > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                          (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area______________________
                     Actual        Max Desirable          Violation?
     v               2103          4400                   No
      12                                                                     !
________________Level of Service Determination (if not F)______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   29.6    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  D

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.447
                                              S
Space mean speed in ramp influence area,     S  = 57.5    mph
                                              R
Space mean speed in outer lanes,             S  = 66.8    mph
                                              0
Space mean speed for all vehicles,           S  = 59.7    mph
_______________________________________________________________________________
```

2030 Gardner IMF Operations - AM Peak Hour - HCS Freeway Ramps

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                      HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                       Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           4510           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              870            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         4510        870                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 1253        242                   v
Trucks and buses                        9           4                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %             %
     Length                             0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.957       0.943
Driver population factor, fP            1.00        1.00
Flow rate, vp                           5237        1025                  pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.582   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  3476   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                5237          7200            No
      Fi   F
     v  = v - v            4212          7200            No
      FO   F   R
     v                     1025          2000            No
      R
     v     v               1761 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                3476          4600                   No
      12                                                                    !
________________Level of Service Determination (if not F)_____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   26.9    pc/mi/ln
                                        R            12         D
Level of service for ramp-freeway junction areas of influence C

______________________________Speed Estimation__________________________________

Intermediate speed variable,                  D  = 0.520
                                               S
Space mean speed in ramp influence area,      S  = 55.4     mph
                                               R
Space mean speed in outer lanes,              S  = 73.8     mph
                                               0
Space mean speed for all vehicles,            S  = 60.5     mph
________________________________________________________________________________
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                      HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                       Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               8 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           5270           vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              510            vph
Length of first accel/decel lane            1000           ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         5270        510                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 1464        142                   v
Trucks and buses                        9           2                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                                      %           %             %
     Length                                     mi          mi            mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.957       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           6119        584                   pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.605   Using Equation  1
                   FM
                  v  = v  (P  ) =  3705    pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     6703          7200            No
      FO
     v     v               2414 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                3705          4400                   No
      12                                                                    !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   32.4    pc/mi/ln
                              R            12             A
Level of service for ramp-freeway junction areas of influence  D

______________________________Speed Estimation__________________________________

Intermediate speed variable,                  M  = 0.535
                                               S
Space mean speed in ramp influence area,      S  = 55.0     mph
                                               R
Space mean speed in outer lanes,              S  = 62.8     mph
                                               0
Space mean speed for all vehicles,            S  = 57.6     mph
________________________________________________________________________________
```

2030 Gardner IMF Operations - AM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               9 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           3640           vph

__________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              1630           vph
Length of first accel/decel lane            500            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         3640        1630                 vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 1011        453                  v
Trucks and buses                        9           2                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.957       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           4226        1865                   pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.591   Using Equation  1
                   FM
                  v  = v  (P  ) =  2500   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     6091          7200            No
      FO
     v     v               1726 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                       Actual        Max Desirable          Violation?
     v                 2500          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   35.5    pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  E

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                M  = 0.593
                                             S
Space mean speed in ramp influence area,    S  = 53.4    mph
                                             R
Space mean speed in outer lanes,            S  = 65.6    mph
                                             0
Space mean speed for all vehicles,          S  = 56.4    mph
_______________________________________________________________________________
```

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Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           3590           vph

_________________________________Off Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     2
Free-Flow speed on ramp                     45.0           mph
Volume on ramp                              1580           vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane           500            ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         3590        1580                 vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 997         439                  v
Trucks and buses                        12          3                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.943       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           4228        1835                   pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.450   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2912   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                4228          7200            No
      Fi   F
     v  = v - v            2393          7200            No
      FO   F   R
     v                     1835          4100            No
      R
     v     v               1316 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                       Actual        Max Desirable          Violation?
     v                 2912          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   10.4    pc/mi/ln
                        R                   12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                D  = 0.463
                                             S
Space mean speed in ramp influence area,    S  = 57.0    mph
                                             R
Space mean speed in outer lanes,            S  = 75.6    mph
                                             0
Space mean speed for all vehicles,          S  = 61.7    mph
_______________________________________________________________________________
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Phone:                                  Fax:
E-mail:

_________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0         mph
Volume on freeway                           2010         vph

__________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0         mph
Volume on ramp                              420          vph
Length of first accel/decel lane            800          ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)______________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2010        420                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 558         117                  v
Trucks and buses                        12          7                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.943       0.905
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2367        516                     pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1420   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2883          7200            No
      FO
     v     v               947  pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v         > 2700 pc/h?        No
      3 or  av34
Is   v     v         > 1.5 v  /2         No
      3 or  av34            12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                1420          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   15.3    pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.292
                                              S
Space mean speed in ramp influence area,     S  = 61.8    mph
                                              R
Space mean speed in outer lanes,             S  = 68.4    mph
                                              0
Space mean speed for all vehicles,           S  = 63.8    mph
_______________________________________________________________________________
```

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Phone:                                  Fax:
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________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0         mph
Volume on freeway                           2430         vph

_________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0         mph
Volume on ramp                              870          vph
Length of first accel/decel lane            800          ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)______________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2430        870                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 675         242                  v
Trucks and buses                        17          7                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.922       0.905
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2930        1068                    pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.638   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  2255   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                2930          7200            No
      Fi   F
     v  = v - v            1862          7200            No
      FO   F   R
     v                     1068          2000            No
      R
     v     v               675  pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v         > 2700 pc/h?        No
      3 or  av34
Is   v     v         > 1.5 v  /2         No
      3 or  av34            12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2255          4600                   No
      12                                                                     !
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   16.4    pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.524
                                              S
Space mean speed in ramp influence area,     S  = 55.3    mph
                                              R
Space mean speed in outer lanes,             S  = 76.8    mph
                                              0
Space mean speed for all vehicles,           S  = 59.1    mph
_______________________________________________________________________________
```

2030 Gardner IMF Operations - AM Peak Hour - HCS Freeway Ramps

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                       HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                           Merge
Number of lanes in freeway                 3
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1560           vph

_________________________________On Ramp Data_________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             180            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1560        180                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                433         50                   v
Trucks and buses                       17          3                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.922       0.957
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1881        209                   pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1128   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2090          7200            No
      FO
     v     v               753  pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                1128          4400                  No
      12                                                                     !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   10.8    pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  B

____________________________Speed Estimation___________________________________

Intermediate speed variable,                 M  = 0.280
                                              S
Space mean speed in ramp influence area,     S  = 62.2    mph
                                              R
Space mean speed in outer lanes,             S  = 69.1    mph
                                              0
Space mean speed for all vehicles,           S  = 64.5    mph
________________________________________________________________________________
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E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               14 Waverly Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 3
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1740           vph

________________________________Off Ramp Data_________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0           mph
Volume on ramp                             580            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1740        580                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                483         161                  v
Trucks and buses                       20          19                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.909       0.778
Driver population factor, fP          1.00        1.00
Flow rate, vp                         2127        828                   pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.669   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  1697   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                2127          7200            No
      Fi   F
     v  = v - v            1299          7200            No
      FO   F   R
     v                     828           2000            No
      R
     v     v               430  pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

_______________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable         Violation?
     v                1697          4600                  No
      12                                                                     !
________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   11.6    pc/mi/ln
                                          R            12          D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation___________________________________

Intermediate speed variable,                 D  = 0.503
                                              S
Space mean speed in ramp influence area,     S  = 55.9    mph
                                              R
Space mean speed in outer lanes,             S  = 76.8    mph
                                              0
Space mean speed for all vehicles,           S  = 59.2    mph
________________________________________________________________________________
```

2030 Gardner IMF Operations - AM Peak Hour - HCS Freeway Ramps

```
                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

________________________________Merge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               15 Waverly Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1160          vph

_________________________________On Ramp Data_______________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              120           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions_______________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1160        120                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 322         33                   v
Trucks and buses                        20          6                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
    Grade                                       %           %           %
    Length                                      mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.909       0.917
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1418        145                     pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1418   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v                     1563          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-8)
         12A

_________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1418          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   12.6    pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  B

____________________________Speed Estimation__________________________________

Intermediate speed variable,                M  = 0.284
                                             S
Space mean speed in ramp influence area,    S  = 62.1    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 62.1    mph
______________________________________________________________________________
```

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Phone:                                    Fax:
E-mail:

________________________________Diverge Analysis____________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               16 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1280          vph

________________________________Off Ramp Data_______________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              170           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions_______________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1280        170                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 356         47                   v
Trucks and buses                        19          4                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
    Grade                               0.00    %   0.00    %           %
    Length                              0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.913       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1557        200                     pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1557   pc/h
                   12   R      F   R   FD

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v  = v                1557          4800            No
      Fi   F
     v  = v - v            1357          4800            No
      FO   F   R
     v                     200           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1557          4600                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   10.4    pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation__________________________________

Intermediate speed variable,                D  = 0.446
                                             S
Space mean speed in ramp influence area,    S  = 57.5    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.5    mph
______________________________________________________________________________
```

2030 Gardner IMF Operations - AM Peak Hour - HCS Freeway Ramps

HCS+: Ramps and Ramp Junctions Release 5.21

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Tom Hiles
Agency/Co.:	HDR Inc.
Date performed:	4/1/2008 4:12:12 PM
Analysis time period:	AM
Freeway/Dir of Travel:	I-35 Southbound
Junction:	17 Sunflower Entr
Jurisdiction:	KDOT
Analysis Year:	2030

Description: NEPA Traffic Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1200	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	90	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1200	90		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	333	25		v
Trucks and buses	19	2		%
Recreational vehicles	0	0		%
Terrain type:	Level	Rolling		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5*	2.5		
Recreational vehicle PCE, ER	1.2*	2.0		
Heavy vehicle adjustment, fHV	0.913	0.971		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	1460	103		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1460 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1563	4800	No
v_{3} or v_{av34}	0 pc/h	(Equation 25-4 or 25-5)	
Is v_{3} or v_{av34} > 2700 pc/h?		No	
Is v_{3} or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} =		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1460	4400	No

!

Level of Service Determination (if not F)

Density, $D = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 12.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.284	
Space mean speed in ramp influence area,	S_R = 62.1	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 62.1	mph

```
                 HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                      Fax:
E-mail:

_________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1350           vph

_________________________________Off Ramp Data________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              90             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1350        90                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 375         25                   v
Trucks and buses                        22          2                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.901       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1665        103                   pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1665   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_________________________________

                            Actual        Maximum         LOS F?
     v  = v                 1665          4800            No
      Fi   F
     v  = v - v             1562          4800            No
      FO   F   R
     v                      103           2000            No
      R
     v     v                0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?            No
      3 or  av34
Is   v     v      > 1.5 v  /2             No
      3 or  av34         12
If yes, v    =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                       Actual        Max Desirable          Violation?
     v                 1665          4600                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   11.4    pc/mi/ln
                                R            12       D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation_________________________________

Intermediate speed variable,                D  = 0.437
                                             S
Space mean speed in ramp influence area,    S  = 57.8    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.8    mph
_______________________________________________________________________________
```

```
                 HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                      Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1260           vph

__________________________________On Ramp Data________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              280            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1260        280                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 350         78                   v
Trucks and buses                        22          4                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.901       0.943
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1554        330                   pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1554   pc/h
                   12   F   FM

______________________________Capacity Checks_________________________________

                            Actual        Maximum         LOS F?
     v                      1884          4800            No
      FO
     v     v                0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?            No
      3 or  av34
Is   v     v      > 1.5 v  /2             No
      3 or  av34         12
If yes, v    =                            (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                       Actual        Max Desirable          Violation?
     v                 1554          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   15.0    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation_________________________________

Intermediate speed variable,                M  = 0.291
                                             S
Space mean speed in ramp influence area,    S  = 61.9    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 61.9    mph
_______________________________________________________________________________
```

```
                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Waverly Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         1540           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0           mph
Volume on ramp                            120            vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1540        120                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               428         33                   v
Trucks and buses                      20          7                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %            %
     Length                           0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.909       0.905
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1882        147                       pcph

_________________________Estimation of V12 Diverge Areas_________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1882   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v  = v                1882          4800            No
      Fi   F
     v  = v - v            1735          4800            No
      FO   F   R
     v                     147           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_______________________
                      Actual        Max Desirable          Violation?
     v                1882          4600                   No
      12                                                                        !
_________________Level of Service Determination (if not F)_______________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   13.2    pc/mi/ln
                       R                  12           D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation___________________________________

Intermediate speed variable,                D  = 0.441
                                             S
Space mean speed in ramp influence area,    S  = 57.6    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.6    mph
_________________________________________________________________________________
```

```
                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Waverly Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                          Merge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0           mph
Volume on freeway                         1420           vph

__________________________________On Ramp Data___________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0           mph
Volume on ramp                            670            vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1420        670                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               394         186                  v
Trucks and buses                      20          23                   %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                                    %           %            %
     Length                                   mi          mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.909       0.743
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1736        1001                      pcph

_________________________Estimation of V12 Merge Areas___________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1041   pc/h
                   12   F   FM

_______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v                     2737          7200            No
      FO
     v     v               695  pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area________________________
                      Actual        Max Desirable          Violation?
     v                1041          4400                   No
      12                                                                        !
_________________Level of Service Determination (if not F)_______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   15.9    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation___________________________________

Intermediate speed variable,                M  = 0.295
                                             S
Space mean speed in ramp influence area,    S  = 61.7    mph
                                             R
Space mean speed in outer lanes,            S  = 69.3    mph
                                             0
Space mean speed for all vehicles,          S  = 63.5    mph
_________________________________________________________________________________
```

```
                 HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                               Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           2100           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              200            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2100        200                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 583         56                   v
Trucks and buses                        21          6                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
    Grade                               0.00    %   0.00     %           %
    Length                              0.00    mi  0.00     mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.905       0.917
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2578        242                  pcph

_________________________Estimation of V12 Diverge Areas_________________________

                  L  =           (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.684   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  1841   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks___________________________________

                           Actual        Maximum        LOS F?
     v  = v                2578          7200           No
      Fi   F
     v  = v - v            2336          7200           No
      FO   F   R
     v                     242           2000           No
      R
     v     v               737  pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_______________________
                      Actual        Max Desirable         Violation?
     v                1841          4600                  No
      12                                                                        !
_________________Level of Service Determination (if not F)_______________________

Density,            D = 4.252 + 0.0086 v  - 0.009  L   =   12.9    pc/mi/ln
                                        R           12         D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation____________________________________

Intermediate speed variable,                 D  = 0.450
                                              S
Space mean speed in ramp influence area,     S  = 57.4    mph
                                              R
Space mean speed in outer lanes,             S  = 76.8    mph
                                              0
Space mean speed for all vehicles,           S  = 61.9    mph
__________________________________________________________________________________
```

```
                 HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                               Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1900           vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              1010           vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1900        1010                 vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 528         281                  v
Trucks and buses                        21          4                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
    Grade                                       %            %           %
    Length                                      mi           mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.905       0.943
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2333        1190                 pcph

_________________________Estimation of V12 Merge Areas___________________________

                  L  =           (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1400   pc/h
                   12   F   FM

_______________________________Capacity Checks___________________________________

                           Actual        Maximum        LOS F?
     v                     3523          7200           No
      FO
     v     v               933  pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area________________________
                      Actual        Max Desirable         Violation?
     v                1400          4400                  No
      12                                                                        !
_________________Level of Service Determination (if not F)_______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v    - 0.00627 L   =   20.1    pc/mi/ln
                              R            12             A
Level of service for ramp-freeway junction areas of influence  C

______________________________Speed Estimation____________________________________

Intermediate speed variable,                 M  = 0.317
                                              S
Space mean speed in ramp influence area,     S  = 61.1    mph
                                              R
Space mean speed in outer lanes,             S  = 68.4    mph
                                              0
Space mean speed for all vehicles,           S  = 62.9    mph
__________________________________________________________________________________
```

HCS+: Ramps and Ramp Junctions Release 5.21

Phone: Fax:
E-mail:

Diverge Analysis

Analyst: Tom Hiles
Agency/Co.: HDR Inc.
Date performed: 4/1/2008 4:12:12 PM
Analysis time period: PM
Freeway/Dir of Travel: I-35 Northbound
Junction: 7 US-56 Exit
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	70.0	mph
Volume on freeway	2900	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	490	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2900	490		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	806	136		v
Trucks and buses	17	9		%
Recreational vehicles	0	0		%
Terrain type:	Level	Rolling		
Grade	0.00 %	0.00 %		%
Length	0.00 mi	0.00 mi		mi
Trucks and buses PCE, ET	1.5*	2.5		
Recreational vehicle PCE, ER	1.2*	2.0		
Heavy vehicle adjustment, fHV	0.922	0.881		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	3496	618		pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)
P_{FD} = 0.644 Using Equation 5
$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2472 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3496	7200	No
$v_{FO} = v_F - v_R$	2878	7200	No
v_R	618	2000	No
v_{3} or v_{av34}	1024 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} =		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2472	4600	No

!

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 18.3 pc/mi/ln
Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, D_S = 0.484
Space mean speed in ramp influence area, S_R = 56.5 mph
Space mean speed in outer lanes, S_0 = 76.7 mph
Space mean speed for all vehicles, S = 61.2 mph

HCS+: Ramps and Ramp Junctions Release 5.21

Phone: Fax:
E-mail:

Merge Analysis

Analyst: Tom Hiles
Agency/Co.: HDR Inc.
Date performed: 4/1/2008 4:12:12 PM
Analysis time period: PM
Freeway/Dir of Travel: I-35 Northbound
Junction: 8 US-56 Entr
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	70.0	mph
Volume on freeway	3740	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	570	vph
Length of first accel/decel lane	1000	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3740	570		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	1039	158		v
Trucks and buses	17	3		%
Recreational vehicles	0	0		%
Terrain type:	Level	Rolling		
Grade	%	%		%
Length	mi	mi		mi
Trucks and buses PCE, ET	1.5*	2.5		
Recreational vehicle PCE, ER	1.2*	2.0		
Heavy vehicle adjustment, fHV	0.922	0.957		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	4509	662		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)
P_{FM} = 0.605 Using Equation 1
$v_{12} = v_F (P_{FM})$ = 2730 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	5171	7200	No
v_3 or v_{av34}	1779 pc/h	(Equation 25-4 or 25-5)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} =		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2730	4400	No

!

Level of Service Determination (if not F)

Density, $D = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 25.4 pc/mi/ln
Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, M_S = 0.367
Space mean speed in ramp influence area, S_R = 59.7 mph
Space mean speed in outer lanes, S_0 = 65.4 mph
Space mean speed for all vehicles, S = 61.6 mph

2030 Gardner IMF Operations - PM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
E-mail:

________________________________Merge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               9 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data________________________________

Type of analysis                          Merge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0          mph
Volume on freeway                         2410          vph

_________________________________On Ramp Data________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            1330          vph
Length of first accel/decel lane          500           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                    Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                        2410        1330                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                669         369                  v
Trucks and buses                       17          3                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

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Heavy vehicle adjustment, fHV           0.922       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2905        1544                    pcph

_________________________Estimation of V12 Merge Areas_______________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.591   Using Equation  1
                   FM
                  v  = v  (P  ) =  1718   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     4449          7200            No
      FO
     v     v               1187 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area___________________
                      Actual        Max Desirable          Violation?
     v                1718          4400                   No
      12                                                                   !
_________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   27.1    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  C

______________________________Speed Estimation_______________________________

Intermediate speed variable,              M  = 0.388
                                           S
Space mean speed in ramp influence area,  S  = 59.1    mph
                                           R
Space mean speed in outer lanes,          S  = 67.5    mph
                                           0
Space mean speed for all vehicles,        S  = 61.2    mph
_____________________________________________________________________________
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Phone:                                  Fax:
E-mail:

________________________________Diverge Analysis_____________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data________________________________

Type of analysis                          Diverge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0          mph
Volume on freeway                         5610          vph

________________________________Off Ramp Data________________________________

Side of freeway                           Right
Number of lanes in ramp                   2
Free-Flow speed on ramp                   45.0          mph
Volume on ramp                            1730          vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane         500           ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                    Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                        5610        1730                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                1558        481                  v
Trucks and buses                       10          2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

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Heavy vehicle adjustment, fHV           0.952       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           6545        1980                    pcph

_________________________Estimation of V12 Diverge Areas_____________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.450   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  4034   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v  = v                6545          7200            No
      Fi   F
     v  = v - v            4565          7200            No
      FO   F   R
     v                     1980          4100            No
      R
     v     v               2511 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable          Violation?
     v                4034          4600                   No
      12                                                                   !
_________________Level of Service Determination (if not F)___________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   20.0+   pc/mi/ln
                                           R          12          D
Level of service for ramp-freeway junction areas of influence C

______________________________Speed Estimation_______________________________

Intermediate speed variable,              D  = 0.476
                                           S
Space mean speed in ramp influence area,  S  = 56.7    mph
                                           R
Space mean speed in outer lanes,          S  = 70.9    mph
                                           0
Space mean speed for all vehicles,        S  = 61.4    mph
_____________________________________________________________________________
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                 HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
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________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                           Merge
Number of lanes in freeway                 3
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          3880          vph

_________________________________On Ramp Data_________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0          mph
Volume on ramp                             930           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        3880        930                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                1078        258                  v
Trucks and buses                       10          3                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.952       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          4527        1080                   pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  2716   pc/h
                   12   F   FM

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     5607          7200            No
      FO
     v     v               1811 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area______________________
                       Actual        Max Desirable         Violation?
     v                 2716          4400                  No
      12                                                                     !
________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   29.6    pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  D

____________________________Speed Estimation__________________________________

Intermediate speed variable,                M  = 0.439
                                             S
Space mean speed in ramp influence area,    S  = 57.7    mph
                                             R
Space mean speed in outer lanes,            S  = 65.3    mph
                                             0
Space mean speed for all vehicles,          S  = 60.0    mph
______________________________________________________________________________
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                 HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 3
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          4810          vph

________________________________Off Ramp Data_________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0          mph
Volume on ramp                             1550          vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        4810        1550                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                1336        431                  v
Trucks and buses                       12          4                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00   %    0.00   %           %
     Length                            0.00   mi   0.00   mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.943       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          5665        1826                   pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.534   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  3877   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                5665          7200            No
      Fi   F
     v  = v - v            3839          7200            No
      FO   F   R
     v                     1826          2000            No
      R
     v     v               1788 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                       Actual        Max Desirable         Violation?
     v                 3877          4600                  No
      12                                                                     !
________________Level of Service Determination (if not F)____________________

Density,                D = 4.252 + 0.0086 v  - 0.009  L   =   30.4    pc/mi/ln
                                            R         12         D
Level of service for ramp-freeway junction areas of influence D

____________________________Speed Estimation__________________________________

Intermediate speed variable,                D  = 0.592
                                             S
Space mean speed in ramp influence area,    S  = 53.4    mph
                                             R
Space mean speed in outer lanes,            S  = 73.7    mph
                                             0
Space mean speed for all vehicles,          S  = 58.5    mph
______________________________________________________________________________
```

2030 Gardner IMF Operations - PM Peak Hour - HCS Freeway Ramps

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                HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                               Fax:
E-mail:

_________________________________Merge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           3260          vph

__________________________________On Ramp Data______________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              420           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        3260        420                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                906         117                   v
Trucks and buses                       12          4                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
    Grade                                      %           %           %
    Length                                     mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.943       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3840        495                   pcph

_________________________Estimation of V12 Merge Areas_______________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  2304   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     4335          7200            No
      FO
     v     v               1536 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area___________________
                      Actual        Max Desirable         Violation?
     v                2304          4400                  No
      12                                                                     !
_________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   22.1    pc/mi/ln
          R                   R            12             A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation________________________________

Intermediate speed variable,                M  = 0.329
                                             S
Space mean speed in ramp influence area,    S  = 60.8    mph
                                             R
Space mean speed in outer lanes,            S  = 66.3    mph
                                             0
Space mean speed for all vehicles,          S  = 62.6    mph
_____________________________________________________________________________
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                HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                               Fax:
E-mail:

_________________________________Diverge Analysis____________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               14 Waverly Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           3680          vph

_________________________________Off Ramp Data______________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              820           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        3680        820                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                1022        228                   v
Trucks and buses                       15          24                    %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
    Grade                              0.00    %   0.00    %           %
    Length                             0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
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Heavy vehicle adjustment, fHV          0.930       0.735
Driver population factor, fP           1.00        1.00
Flow rate, vp                          4396        1239                  pcph

_________________________Estimation of V12 Diverge Areas_____________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.593   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  3111   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v  = v                4396          7200            No
      Fi   F
     v  = v - v            3157          7200            No
      FO   F   R
     v                     1239          2000            No
      R
     v     v               1285 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable         Violation?
     v                3111          4600                  No
      12                                                                     !
_________________Level of Service Determination (if not F)___________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   23.8    pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation________________________________

Intermediate speed variable,                D  = 0.540
                                             S
Space mean speed in ramp influence area,    S  = 54.9    mph
                                             R
Space mean speed in outer lanes,            S  = 75.7    mph
                                             0
Space mean speed for all vehicles,          S  = 59.7    mph
_____________________________________________________________________________
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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                     Fax:
E-mail:

_________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               15 Waverly Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          2860          vph

__________________________________On Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0          mph
Volume on ramp                             340           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)______________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        2860        340                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                794         94                   v
Trucks and buses                       15          4                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.930       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3416        400                   pcph

_________________________Estimation of V12 Merge Areas__________________________

                  L  =           (Equation 25-2 or 25-3)
                   EQ
                  P  =   1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  3416   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum        LOS F?
     v                     3816          4800           No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area________________________
                      Actual        Max Desirable          Violation?
     v                3416          4400                   No
      12                                                                        !
_________________Level of Service Determination (if not F)______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   30.0    pc/mi/ln
          R                  R            12             A
Level of service for ramp-freeway junction areas of influence  D

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                M  = 0.442
                                             S
Space mean speed in ramp influence area,    S  = 57.6    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.6    mph
________________________________________________________________________________
```

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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                     Fax:
E-mail:

________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               16 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          3200          vph

_________________________________Off Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0          mph
Volume on ramp                             660           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)______________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        3200        660                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                889         183                  v
Trucks and buses                       11          2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.948       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3751        755                   pcph

_________________________Estimation of V12 Diverge Areas________________________

                  L  =           (Equation 25-8 or 25-9)
                   EQ
                  P  =   1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  3751   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum        LOS F?
     v  = v                3751          4800           No
      Fi   F
     v  = v - v            2996          4800           No
      FO   F   R
     v                     755           2000           No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                3751          4600                   No
      12                                                                        !
_________________Level of Service Determination (if not F)______________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   29.3    pc/mi/ln
                                          R            12         D
Level of service for ramp-freeway junction areas of influence D

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                D  = 0.496
                                             S
Space mean speed in ramp influence area,    S  = 56.1    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 56.1    mph
________________________________________________________________________________
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2030 Gardner IMF Operations - PM Peak Hour - HCS Freeway Ramps

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              HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis_______________________________

Analyst:                030 IMF+LP_I-35 Northbound_AM_
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:12:12 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               17 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0            mph
Volume on freeway                           2540            vph

__________________________________On Ramp Data________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0            mph
Volume on ramp                              190             vph
Length of first accel/decel lane            800             ft
Length of second accel/decel lane                           ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                     vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                   ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2540        190                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 706         53                    v
Trucks and buses                        11          4                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                                      %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV          0.948       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2977        224                     pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L   =            (Equation 25-2 or 25-3)
                   EQ
                  P   =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2977   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     3201          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                2977          4400                  No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   25.3    pc/mi/ln
          R                   R           12           A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.361
                                              S
Space mean speed in ramp influence area,     S  = 59.9    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 59.9    mph
_______________________________________________________________________________
```

Appendix F:
Results of Operational Analysis
Future Gardner IMF Operations + Induced Development

Synchro Analysis

1. 2010 Gardner IMF Operations + Induced Development
2. 2015 Gardner IMF Operations + Induced Development
3. 2030 Gardner IMF Operations + Induced Development

HCS Analysis

1. 2010 Gardner IMF Operations + Induced Development
2. 2015 Gardner IMF Operations + Induced Development
3. 2030 Gardner IMF Operations + Induced Development

2010 Gardner IMF Operations + Induced Development - AM Peak Hour - Synchro Intersection LOS

1: 175th Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	60	290	10	0	50	50	5	80	5	90	30	10
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	72	349	12	0	60	60	6	96	6	108	36	12
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	120			361			620	620	355	645	596	90
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	120			361			620	620	355	645	596	90
tC, single (s)	4.1			4.1			7.3	6.5	6.2	7.1	6.5	6.3
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.7	4.0	3.3	3.5	4.0	3.4
p0 queue free %	95			100			98	75	99	63	91	99
cM capacity (veh/h)	1449			1208			332	382	693	294	395	946

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	434	120	108	157
Volume Left	72	0	6	108
Volume Right	12	60	6	12
cSH	1449	1208	389	331
Volume to Capacity	0.05	0.00	0.28	0.47
Queue Length 95th (ft)	4	0	28	61
Control Delay (s)	1.7	0.0	17.8	25.2
Lane LOS	A		C	D
Approach Delay (s)	1.7	0.0	17.8	25.2
Approach LOS			C	D

Intersection Summary			
Average Delay	8.1		
Intersection Capacity Utilization	46.4%	ICU Level of Service	A
Analysis Period (min)	15		

2: US 56 & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	560	60	100	220	100	70	320	190	140	200	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.99			0.96		1.00	0.94		1.00	0.98	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3363			3175		1805	1725		1736	1794	
Flt Permitted		0.89			0.62		0.60	1.00		0.25	1.00	
Satd. Flow (perm)		3015			2005		1133	1725		452	1794	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	46	644	69	115	253	115	80	368	218	161	230	34
RTOR Reduction (vph)	0	15	0	0	61	0	0	31	0	0	8	0
Lane Group Flow (vph)	0	744	0	0	422	0	80	555	0	161	256	0
Heavy Vehicles (%)	5%	6%	2%	7%	10%	6%	0%	4%	4%	4%	4%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		18.1			18.1		19.4	19.4		19.4	19.4	
Effective Green, g (s)		18.1			18.1		19.4	19.4		19.4	19.4	
Actuated g/C Ratio		0.37			0.37		0.39	0.39		0.39	0.39	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1109			738		447	680		178	707	
v/s Ratio Prot								0.32			0.14	
v/s Ratio Perm		c0.25			0.21		0.07			c0.36		
v/c Ratio		0.67			0.57		0.18	0.82		0.90	0.36	
Uniform Delay, d1		13.0			12.5		9.7	13.3		14.0	10.5	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.6			1.1		0.2	7.5		41.1	0.3	
Delay (s)		14.7			13.5		9.9	20.8		55.1	10.8	
Level of Service		B			B		A	C		E	B	
Approach Delay (s)		14.7			13.5			19.5			27.6	
Approach LOS		B			B			B			C	

Intersection Summary			
HCM Average Control Delay	18.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	49.2	Sum of lost time (s)	11.7
Intersection Capacity Utilization	87.0%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

3: US 56 & Elm

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	880	10	10	390	40	10	5	20	70	5	20
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			0.99			0.92			0.97	
Flt Protected		1.00			1.00			0.99			0.96	
Satd. Flow (prot)		3615			3467			1817			1853	
Flt Permitted		0.94			0.93			0.91			0.76	
Satd. Flow (perm)		3407			3238			1677			1458	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	22	946	11	11	419	43	11	5	22	75	5	22
RTOR Reduction (vph)	0	1	0	0	7	0	0	19	0	0	19	0
Lane Group Flow (vph)	0	978	0	0	466	0	0	19	0	0	83	0
Heavy Vehicles (%)	0%	5%	0%	0%	9%	0%	0%	0%	0%	0%	0%	5%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		30.9			30.9			6.1			6.1	
Effective Green, g (s)		30.9			30.9			6.1			6.1	
Actuated g/C Ratio		0.67			0.67			0.13			0.13	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2289			2175			222			193	
v/s Ratio Prot												
v/s Ratio Perm		c0.29			0.14			0.01			c0.06	
v/c Ratio		0.43			0.21			0.09			0.43	
Uniform Delay, d1		3.5			2.9			17.5			18.3	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.1			0.0			0.2			1.5	
Delay (s)		3.6			2.9			17.7			19.9	
Level of Service		A			A			B			B	
Approach Delay (s)		3.6			2.9			17.7			19.9	
Approach LOS		A			A			B			B	

Intersection Summary			
HCM Average Control Delay	4.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	46.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	56.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

4: US 56 & Mulberry

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	960	10	10	390	50	5	5	20	90	5	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			0.98			0.91			0.97	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3427			3262			1605			1737	
Flt Permitted		0.93			0.93			0.95			0.77	
Satd. Flow (perm)		3204			3039			1530			1378	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	32	1032	11	11	419	54	5	5	22	97	5	32
RTOR Reduction (vph)	0	1	0	0	13	0	0	18	0	0	24	0
Lane Group Flow (vph)	0	1074	0	0	471	0	0	14	0	0	110	0
Heavy Vehicles (%)	7%	5%	0%	0%	9%	8%	0%	20%	5%	2%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		33.0			33.0			8.0			8.0	
Effective Green, g (s)		33.0			33.0			8.0			8.0	
Actuated g/C Ratio		0.66			0.66			0.16			0.16	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2115			2006			245			220	
v/s Ratio Prot												
v/s Ratio Perm		c0.34			0.15			0.01			c0.08	
v/c Ratio		0.51			0.23			0.06			0.50	
Uniform Delay, d1		4.3			3.4			17.8			19.2	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.2			0.1			0.1			1.8	
Delay (s)		4.5			3.5			17.9			20.9	
Level of Service		A			A			B			C	
Approach Delay (s)		4.5			3.5			17.9			20.9	
Approach LOS		A			A			B			C	

Intersection Summary			
HCM Average Control Delay	5.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	50.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	69.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

2010 Gardner IMF Operations + Induced Development - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
5: US 56 & Moonlight Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	910	130	40	300	160	120	120	110	430	150	50
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1703	3619	1568	1752	3282	1583	1752	3505	1538	3400	3505	1524
Flt Permitted	0.54	1.00	1.00	0.20	1.00	1.00	0.65	1.00	1.00	0.43	1.00	1.00
Satd. Flow (perm)	959	3619	1568	369	3282	1583	1194	3505	1538	1546	3505	1524
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	77	1000	143	44	330	176	132	132	121	473	165	55
RTOR Reduction (vph)	0	0	77	0	0	97	0	0	109	0	0	47
Lane Group Flow (vph)	77	1000	66	44	330	79	132	132	12	473	165	8
Heavy Vehicles (%)	6%	5%	3%	3%	10%	2%	3%	3%	5%	3%	3%	6%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6	8		8	4		4
Actuated Green, G (s)	46.5	41.6	41.6	43.9	40.3	40.3	17.1	8.6	8.6	26.5	13.3	13.3
Effective Green, g (s)	46.5	41.6	41.6	43.9	40.3	40.3	17.1	8.6	8.6	26.5	13.3	13.3
Actuated g/C Ratio	0.52	0.46	0.46	0.49	0.45	0.45	0.19	0.10	0.10	0.29	0.15	0.15
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	536	1673	725	235	1470	709	280	335	147	727	518	225
v/s Ratio Prot	c0.01	c0.28		0.01	0.10		0.04	0.04		c0.10	0.05	
v/s Ratio Perm	0.07		0.04	0.08		0.05	0.05		0.01	c0.10		0.01
v/c Ratio	0.14	0.60	0.09	0.19	0.22	0.11	0.47	0.39	0.08	0.65	0.32	0.04
Uniform Delay, d1	11.0	18.0	13.6	13.0	15.3	14.4	31.9	38.3	37.1	26.2	34.3	32.9
Progression Factor	1.00	1.00	1.00	1.21	1.22	2.91	0.93	0.93	0.71	1.00	1.00	1.00
Incremental Delay, d2	0.0	1.6	0.2	0.1	0.4	0.3	0.5	0.3	0.1	1.6	0.1	0.0
Delay (s)	11.1	19.6	13.8	15.8	19.0	42.3	30.1	36.0	26.5	27.8	34.4	32.9
Level of Service	B	B	B	B	B	D	C	D	C	C	C	C
Approach Delay (s)		18.4			26.2			31.0			29.8	
Approach LOS		B			C			C			C	

Intersection Summary			
HCM Average Control Delay	24.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	16.5
Intersection Capacity Utilization	67.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
6: Old US 56 & US 56 — AM Peak Hour

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	40	10	1250	210	10	470
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	4.0	5.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1752	1615	3654	1568	1805	3551
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1752	1615	3654	1568	1805	3551
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	41	10	1289	216	10	485
RTOR Reduction (vph)	0	9	0	83	0	0
Lane Group Flow (vph)	41	1	1289	133	10	485
Heavy Vehicles (%)	3%	0%	4%	3%	0%	7%
Turn Type		Perm		custom	Prot	
Protected Phases	8		2	4	1	6
Permitted Phases		8				
Actuated Green, G (s)	12.7	12.7	61.9	12.7	1.4	67.3
Effective Green, g (s)	12.7	12.7	61.9	12.7	1.4	67.3
Actuated g/C Ratio	0.14	0.14	0.69	0.14	0.02	0.75
Clearance Time (s)	5.0	5.0	5.0	5.0	4.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	247	228	2513	221	28	2655
v/s Ratio Prot	0.02		c0.35	c0.08	0.01	c0.14
v/s Ratio Perm		0.00				
v/c Ratio	0.17	0.01	0.51	0.60	0.36	0.18
Uniform Delay, d1	34.0	33.2	6.8	36.3	43.9	3.3
Progression Factor	1.00	1.00	0.58	1.48	1.00	1.00
Incremental Delay, d2	0.3	0.0	0.6	3.7	7.7	0.2
Delay (s)	34.3	33.2	4.6	57.4	51.5	3.5
Level of Service	C	C	A	E	D	A
Approach Delay (s)	34.1		12.2			4.4
Approach LOS	C		B			A

Intersection Summary			
HCM Average Control Delay	10.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	47.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
7: US-56 & Cedar Niles — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	1280	90	230	1100	60	80	20	450	40	10	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00		1.00	0.88	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85	1.00	0.88	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1805	3689	1615	3433	3689	1615		1827	2842	1752	1606	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.73	1.00	0.68	1.00	
Satd. Flow (perm)	1805	3689	1615	3433	3689	1615		1387	2842	1263	1606	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	45	1438	101	258	1236	67	90	22	506	45	11	45
RTOR Reduction (vph)	0	0	53	0	0	27	0	0	257	0	38	0
Lane Group Flow (vph)	45	1438	48	258	1236	40	0	112	249	45	18	0
Heavy Vehicles (%)	0%	3%	0%	2%	3%	0%	0%	0%	0%	3%	0%	5%
Turn Type	Prot		Perm	Prot		Perm	Perm		Perm	Perm		
Protected Phases	5	2		1	6			8			4	
Permitted Phases			2			6	8		8	4		
Actuated Green, G (s)	4.4	34.0	34.0	10.2	39.8	39.8		11.7	11.7	11.7	11.7	
Effective Green, g (s)	4.4	34.0	34.0	10.2	39.8	39.8		11.7	11.7	11.7	11.7	
Actuated g/C Ratio	0.06	0.48	0.48	0.14	0.56	0.56		0.16	0.16	0.16	0.16	
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0	
Lane Grp Cap (vph)	111	1754	768	490	2053	899		227	465	207	263	
v/s Ratio Prot	0.02	c0.39		c0.08	0.34						0.01	
v/s Ratio Perm			0.03			0.02		0.08	c0.09	0.04		
v/c Ratio	0.41	0.82	0.06	0.53	0.60	0.04		0.49	0.54	0.22	0.07	
Uniform Delay, d1	32.3	16.1	10.1	28.4	10.6	7.2		27.2	27.4	25.9	25.3	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.9	3.0	0.0	0.5	0.3	0.0		0.6	0.6	0.2	0.0	
Delay (s)	33.2	19.1	10.1	28.9	10.9	7.2		27.8	28.0	26.1	25.3	
Level of Service	C	B	B	C	B	A		C	C	C	C	
Approach Delay (s)		18.9			13.7			28.0			25.7	
Approach LOS		B			B			C			C	

Intersection Summary			
HCM Average Control Delay	18.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	71.5	Sum of lost time (s)	15.6
Intersection Capacity Utilization	71.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
8: US-56 & I-35 SB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1720	40	30	470	0	0	0	0	50	0	920
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					2.5		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		1.00		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3513		1641	3689					1641		2760
Flt Permitted		1.00		0.95	1.00					0.95		1.00
Satd. Flow (perm)		3513		1641	3689					1641		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1811	42	32	495	0	0	0	0	53	0	968
RTOR Reduction (vph)	0	1	0	0	0	0	0	0	0	0	0	301
Lane Group Flow (vph)	0	1852	0	32	495	0	0	0	0	53	0	667
Heavy Vehicles (%)	0%	2%	20%	10%	3%	0%	0%	0%	0%	10%	0%	3%
Turn Type				Prot						Prot		custom
Protected Phases		2		1	6					7		5
Permitted Phases												4
Actuated Green, G (s)		67.8		4.2	42.0					5.5		30.0
Effective Green, g (s)		67.8		4.2	42.0					5.5		30.0
Actuated g/C Ratio		0.75		0.05	0.47					0.06		0.33
Clearance Time (s)		5.0		5.0	5.0					2.5		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2646		77	1722					100		920
v/s Ratio Prot		c0.53		0.02	c0.13					c0.03		0.24
v/s Ratio Perm												
v/c Ratio		0.70		0.42	0.29					0.53		0.73
Uniform Delay, d1		5.8		41.7	14.8					41.0		26.4
Progression Factor		1.00		1.07	0.82					1.00		1.00
Incremental Delay, d2		1.6		3.3	0.4					5.3		2.9
Delay (s)		7.4		47.8	12.6					46.3		29.2
Level of Service		A		D	B					D		C
Approach Delay (s)		7.4			14.7			0.0			30.1	
Approach LOS		A			B			A			C	

Intersection Summary			
HCM Average Control Delay	15.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.5
Intersection Capacity Utilization	59.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

9: US-56 & I-35 NB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	350	0	0	350	130	150	0	90	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			0.96			0.95				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3725			1795			1625				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3725			1795			1625				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	398	0	0	398	148	170	0	102	0	0	0
RTOR Reduction (vph)	0	0	0	0	11	0	0	29	0	0	0	0
Lane Group Flow (vph)	0	398	0	0	535	0	0	243	0	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	2%	8%	0%	7%	0%	0%	0%
Turn Type							Perm					
Protected Phases		2			6			8				
Permitted Phases							8					
Actuated Green, G (s)		61.3			61.3			18.7				
Effective Green, g (s)		61.3			61.3			18.7				
Actuated g/C Ratio		0.68			0.68			0.21				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		2537			1223			338				
v/s Ratio Prot		0.11			c0.30							
v/s Ratio Perm								0.15				
v/c Ratio		0.16			0.44			0.72				
Uniform Delay, d1		5.1			6.5			33.2				
Progression Factor		0.48			1.00			1.00				
Incremental Delay, d2		0.1			1.1			7.4				
Delay (s)		2.6			7.7			40.6				
Level of Service		A			A			D				
Approach Delay (s)		2.6			7.7			40.6			0.0	
Approach LOS		A			A			D			A	

Intersection Summary			
HCM Average Control Delay	13.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	91.3%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

10: Sante Fe & — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	40	90	260	70	120	190
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.97		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1752	1583	3382		1770	3471
Flt Permitted	0.95	1.00	1.00		0.54	1.00
Satd. Flow (perm)	1752	1583	3382		1005	3471
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	43	97	280	75	129	204
RTOR Reduction (vph)	0	90	12	0	0	0
Lane Group Flow (vph)	43	7	343	0	129	204
Heavy Vehicles (%)	3%	2%	4%	1%	2%	4%
Turn Type		Perm			Perm	
Protected Phases	6		8			4
Permitted Phases		6			4	
Actuated Green, G (s)	6.7	6.7	73.3		73.3	73.3
Effective Green, g (s)	6.7	6.7	73.3		73.3	73.3
Actuated g/C Ratio	0.07	0.07	0.81		0.81	0.81
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	130	118	2754		819	2827
v/s Ratio Prot	c0.02		0.10			0.06
v/s Ratio Perm		0.00			c0.13	
v/c Ratio	0.33	0.06	0.12		0.16	0.07
Uniform Delay, d1	39.5	38.7	1.7		1.8	1.6
Progression Factor	1.00	1.00	1.00		0.61	0.47
Incremental Delay, d2	1.5	0.2	0.1		0.4	0.0
Delay (s)	41.0	38.9	1.8		1.5	0.8
Level of Service	D	D	A		A	A
Approach Delay (s)	39.6		1.8			1.1
Approach LOS	D		A			A

Intersection Summary			
HCM Average Control Delay	7.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.17		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	34.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

11: Waverly Road & US 56 — AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	20	20	10	10	10	60	250	0	30	80	10
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	25	25	13	13	13	76	316	0	38	101	13
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	671	658	316	690	652	108	114			316		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	671	658	316	690	652	108	114			316		
tC, single (s)	7.1	6.6	6.4	7.1	6.6	6.3	4.1			4.2		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.4	3.5	4.1	3.4	2.2			2.3		
p0 queue free %	100	93	96	96	96	99	95			97		
cM capacity (veh/h)	335	349	695	309	346	925	1469			1216		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	51	38	392	152
Volume Left	0	13	76	38
Volume Right	25	13	0	13
cSH	465	417	1469	1216
Volume to Capacity	0.11	0.09	0.05	0.03
Queue Length 95th (ft)	9	7	4	2
Control Delay (s)	13.7	14.5	1.9	2.2
Lane LOS	B	B	A	A
Approach Delay (s)	13.7	14.5	1.9	2.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	3.6		
Intersection Capacity Utilization	35.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

12: 183rd Street & Four Corners Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	5	5	5	10	5	10	10	5	5	10	5
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	5	5	11	5	11	11	5	5	11	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	16	22	27	22
Volume Left (vph)	5	5	11	5
Volume Right (vph)	5	5	5	5
Hadj (s)	-0.13	-0.10	-0.04	-0.10
Departure Headway (s)	3.9	3.9	4.0	3.9
Degree Utilization, x	0.02	0.02	0.03	0.02
Capacity (veh/h)	907	902	887	907
Control Delay (s)	7.0	7.0	7.1	7.0
Approach Delay (s)	7.0	7.0	7.1	7.0
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.0		
HCM Level of Service	A		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
13: 183rd Street & US 56 — AM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	5	0	0	310	80	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	0	0	392	101	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	497	104	108			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	497	104	108			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	99	100	100			
cM capacity (veh/h)	536	956	1496			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	6	392	108
Volume Left	6	0	0
Volume Right	0	0	6
cSH	536	1496	1700
Volume to Capacity	0.01	0.00	0.06
Queue Length 95th (ft)	1	0	0
Control Delay (s)	11.8	0.0	0.0
Lane LOS	B		
Approach Delay (s)	11.8	0.0	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	26.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
14: 183rd Street & Waverly Road — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	10	10	20	10	5	40
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	11	22	11	5	43
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	82	27			33	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	82	27			33	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	99			100	
cM capacity (veh/h)	922	1054			1592	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	22	33	49
Volume Left	11	0	5
Volume Right	11	11	0
cSH	984	1700	1592
Volume to Capacity	0.02	0.02	0.00
Queue Length 95th (ft)	2	0	0
Control Delay (s)	8.7	0.0	0.8
Lane LOS	A		A
Approach Delay (s)	8.7	0.0	0.8
Approach LOS	A		

Intersection Summary			
Average Delay	2.2		
Intersection Capacity Utilization	16.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
15: 183rd Street & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	20	90	110	20	90	30	410	40	30	350	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.88		1.00	0.88		1.00	0.99		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1805	1666		1805	1666		1805	3437		1805	3482	
Flt Permitted	0.68	1.00		0.68	1.00		0.51	1.00		0.47	1.00	
Satd. Flow (perm)	1288	1666		1288	1666		967	3437		885	3482	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	45	22	101	124	22	101	34	461	45	34	393	22
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	45	123	0	124	123	0	34	506	0	34	415	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	4%	0%	0%	3%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	7.1	7.1		7.1	7.1		13.5	13.5		13.5	13.5	
Effective Green, g (s)	7.1	7.1		7.1	7.1		13.5	13.5		13.5	13.5	
Actuated g/C Ratio	0.23	0.23		0.23	0.23		0.44	0.44		0.44	0.44	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	299	387		299	387		427	1516		390	1536	
v/s Ratio Prot		0.07			0.07			c0.15			0.12	
v/s Ratio Perm	0.03			c0.10			0.04			0.04		
v/c Ratio	0.15	0.32		0.41	0.32		0.08	0.33		0.09	0.27	
Uniform Delay, d1	9.4	9.7		10.0	9.7		5.0	5.6		5.0	5.4	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.2	0.5		0.9	0.5		0.1	0.1		0.1	0.1	
Delay (s)	9.6	10.2		10.9	10.2		5.0	5.7		5.1	5.5	
Level of Service	A	B		B	B		A	A		A	A	
Approach Delay (s)		10.0			10.6			5.7			5.5	
Approach LOS		B			B			A			A	

Intersection Summary			
HCM Average Control Delay	7.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.36		
Actuated Cycle Length (s)	30.6	Sum of lost time (s)	10.0
Intersection Capacity Utilization	43.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
16: Four Corners Road & US 56 — AM Peak Hour

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	0	5	10	310	90	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	0	7	13	408	118	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	553	118	118			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	553	118	118			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	99	99			
cM capacity (veh/h)	493	939	1482			

Direction, Lane #	SB 1	NE 1	SW 1
Volume Total	7	421	118
Volume Left	0	13	0
Volume Right	7	0	0
cSH	939	1482	1700
Volume to Capacity	0.01	0.01	0.07
Queue Length 95th (ft)	1	1	0
Control Delay (s)	8.9	0.3	0.0
Lane LOS	A	A	
Approach Delay (s)	8.9	0.3	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	33.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

17: 191st Street & US 56

AM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	10	5	0	320	90	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	13	6	0	416	117	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	536	120	123			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	536	120	123			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	99	100			
cM capacity (veh/h)	509	937	1476			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	19	416	123
Volume Left	13	0	0
Volume Right	6	0	6
cSH	600	1476	1700
Volume to Capacity	0.03	0.00	0.07
Queue Length 95th (ft)	3	0	0
Control Delay (s)	11.2	0.0	0.0
Lane LOS	B		
Approach Delay (s)	11.2	0.0	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	26.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

19: 191st Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	120	5	5	140	30	5	5	5	30	5	30
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	130	5	5	152	33	5	5	5	33	5	33
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	185			136			370	351	133	342	337	168
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	185			136			370	351	133	342	337	168
tC, single (s)	4.5			4.1			7.1	6.5	6.2	7.1	6.5	6.3
tC, 2 stage (s)												
tF (s)	2.6			2.2			3.5	4.0	3.3	3.5	4.0	3.4
p0 queue free %	99			100			99	99	99	95	99	96
cM capacity (veh/h)	1191			1461			559	570	921	602	580	855

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	147	190	16	71
Volume Left	11	5	5	33
Volume Right	5	33	5	33
cSH	1191	1461	648	695
Volume to Capacity	0.01	0.00	0.03	0.10
Queue Length 95th (ft)	1	0	2	8
Control Delay (s)	0.7	0.2	10.7	10.8
Lane LOS	A	A	B	B
Approach Delay (s)	0.7	0.2	10.7	10.8
Approach LOS			B	B

Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	23.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

20: W 191st Street & Gardner Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	5	150	10	5	10	160	250	5	5	490	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00			0.95			0.95	1.00
Frt	1.00	1.00	0.85		0.94			1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00		0.98			0.98			1.00	1.00
Satd. Flow (prot)	1805	1900	1049		1760			3029			3538	1468
Flt Permitted	0.74	1.00	1.00		0.89			0.65			0.95	1.00
Satd. Flow (perm)	1405	1900	1049		1590			2010			3370	1468
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	11	5	158	11	5	11	168	263	5	5	516	11
RTOR Reduction (vph)	0	0	140	0	10	0	0	0	0	0	0	3
Lane Group Flow (vph)	11	5	18	0	17	0	0	436	0	0	521	8
Heavy Vehicles (%)	0%	0%	54%	0%	0%	0%	34%	6%	0%	0%	2%	10%
Turn Type	Perm		Perm	Perm			Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	9.1	9.1	9.1		9.1			60.9			60.9	60.9
Effective Green, g (s)	9.1	9.1	9.1		9.1			60.9			60.9	60.9
Actuated g/C Ratio	0.11	0.11	0.11		0.11			0.76			0.76	0.76
Clearance Time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	160	216	119		181			1530			2565	1118
v/s Ratio Prot		0.00										
v/s Ratio Perm	0.01		c0.02		0.01			c0.22			0.15	0.01
v/c Ratio	0.07	0.02	0.15		0.10			0.28			0.20	0.01
Uniform Delay, d1	31.7	31.5	32.0		31.8			2.9			2.7	2.3
Progression Factor	1.00	1.00	1.00		1.00			0.64			1.00	1.00
Incremental Delay, d2	0.2	0.0	0.6		0.2			0.4			0.2	0.0
Delay (s)	31.8	31.5	32.6		32.0			2.3			2.9	2.3
Level of Service	C	C	C		C			A			A	A
Approach Delay (s)		32.5			32.0			2.3			2.9	
Approach LOS		C			C			A			A	

Intersection Summary			
HCM Average Control Delay	7.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.27		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	46.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

21: I-35 SB Ramps & Gardner Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	40	0	200	10	210	0	0	610	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0		5.0		5.0			5.0	5.0
Lane Util. Factor				1.00		1.00		1.00			1.00	1.00
Frt				1.00		0.85		1.00			1.00	0.85
Flt Protected				0.95		1.00		1.00			1.00	1.00
Satd. Flow (prot)				1671		1233		1826			1667	1468
Flt Permitted				0.95		1.00		0.97			1.00	1.00
Satd. Flow (perm)				1671		1233		1780			1667	1468
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	43	0	213	11	223	0	0	649	53
RTOR Reduction (vph)	0	0	0	0	0	189	0	0	0	0	0	13
Lane Group Flow (vph)	0	0	0	43	0	24	0	234	0	0	649	40
Heavy Vehicles (%)	0%	0%	0%	8%	0%	31%	0%	4%	0%	0%	14%	10%
Turn Type				Prot		custom	Perm					Perm
Protected Phases				3				2			6	
Permitted Phases						3	2					6
Actuated Green, G (s)				9.1		9.1		60.9			60.9	60.9
Effective Green, g (s)				9.1		9.1		60.9			60.9	60.9
Actuated g/C Ratio				0.11		0.11		0.76			0.76	0.76
Clearance Time (s)				5.0		5.0		5.0			5.0	5.0
Vehicle Extension (s)				3.0		3.0		3.0			3.0	3.0
Lane Grp Cap (vph)				190		140		1355			1269	1118
v/s Ratio Prot				c0.03							c0.39	
v/s Ratio Perm						0.02		0.13				0.03
v/c Ratio				0.23		0.17		0.17			0.51	0.04
Uniform Delay, d1				32.2		32.0		2.6			3.7	2.3
Progression Factor				1.00		1.00		0.84			0.91	0.68
Incremental Delay, d2				0.6		0.6		0.3			1.5	0.1
Delay (s)				32.9		32.6		2.5			4.9	1.7
Level of Service				C		C		A			A	A
Approach Delay (s)		0.0			32.7			2.5			4.6	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM Average Control Delay	10.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	42.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

22: I-35 NB Ramps & Gardner Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	90	0	10	0	0	0	0	140	180	530	120	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.99						0.92			1.00	
Flt Protected		0.96						1.00			0.96	
Satd. Flow (prot)		1730						1707			1610	
Flt Permitted		0.96						1.00			0.56	
Satd. Flow (perm)		1730						1707			930	
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	99	0	11	0	0	0	0	154	198	582	132	0
RTOR Reduction (vph)	0	5	0	0	0	0	0	39	0	0	0	0
Lane Group Flow (vph)	0	105	0	0	0	0	0	313	0	0	714	0
Heavy Vehicles (%)	3%	0%	10%	0%	0%	0%	0%	4%	2%	16%	2%	0%
Turn Type	Perm									Perm		
Protected Phases		4						2			6	
Permitted Phases	4									6		
Actuated Green, G (s)		5.6						64.4			64.4	
Effective Green, g (s)		5.6						64.4			64.4	
Actuated g/C Ratio		0.07						0.80			0.80	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		121						1374			749	
v/s Ratio Prot								0.18				
v/s Ratio Perm		0.06									c0.77	
v/c Ratio		0.87						0.23			0.95	
Uniform Delay, d1		36.8						1.9			6.5	
Progression Factor		1.00						1.00			0.98	
Incremental Delay, d2		44.8						0.4			21.6	
Delay (s)		81.7						2.2			28.1	
Level of Service		F						A			C	
Approach Delay (s)		81.7			0.0			2.2			28.1	
Approach LOS		F			A			A			C	

Intersection Summary			
HCM Average Control Delay	25.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	72.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

23: E 191st Street & Gardner Rd — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	10	310	0	5	130
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	11	333	0	5	140
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						220
pX, platoon unblocked						
vC, conflicting volume	484	333			333	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	484	333			333	
tC, single (s)	6.4	6.2			4.3	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.4	
p0 queue free %	100	98			100	
cM capacity (veh/h)	543	713			1132	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	11	333	145
Volume Left	0	0	5
Volume Right	11	0	0
cSH	713	1700	1132
Volume to Capacity	0.02	0.20	0.00
Queue Length 95th (ft)	1	0	0
Control Delay (s)	10.1	0.0	0.3
Lane LOS	B		A
Approach Delay (s)	10.1	0.0	0.3
Approach LOS	B		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	26.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

24: Sunflower Road & US 56 — AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	10	30	0	0	10	320	60	5	90	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	6	13	38	0	0	13	405	76	6	114	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	595	633	114	611	595	443	114			481		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	595	633	114	611	595	443	114			481		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	90	100	100	99			99		
cM capacity (veh/h)	414	394	944	380	414	619	1488			1092		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	25	38	494	120
Volume Left	6	38	13	6
Volume Right	13	0	76	0
cSH	566	380	1488	1092
Volume to Capacity	0.04	0.10	0.01	0.01
Queue Length 95th (ft)	4	8	1	0
Control Delay (s)	11.7	15.5	0.3	0.5
Lane LOS	B	C	A	A
Approach Delay (s)	11.7	15.5	0.3	0.5
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	35.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

25: US 56 & 4th Street — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	350	50	10	110	10	30
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	449	64	13	141	13	38
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			513		647	481
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			513		647	481
tC, single (s)			4.2		6.5	6.2
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.3
p0 queue free %			99		97	93
cM capacity (veh/h)			1013		418	583

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	513	154	51
Volume Left	0	13	13
Volume Right	64	0	38
cSH	1700	1013	531
Volume to Capacity	0.30	0.01	0.10
Queue Length 95th (ft)	0	1	8
Control Delay (s)	0.0	0.8	12.5
Lane LOS		A	B
Approach Delay (s)	0.0	0.8	12.5
Approach LOS			B

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	31.5%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Gardner IMF Operations + Induced Development - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

26: 199th Street & Four Corners Road

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	60	30	20	5	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	6	71	36	24	6	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	60				131	48
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	60				131	48
tC, single (s)	4.3				6.6	6.6
tC, 2 stage (s)						
tF (s)	2.4				3.7	3.7
p0 queue free %	100				99	99
cM capacity (veh/h)	1437				819	923

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	77	60	12
Volume Left	6	0	6
Volume Right	0	24	6
cSH	1437	1700	868
Volume to Capacity	0.00	0.04	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.6	0.0	9.2
Lane LOS	A		A
Approach Delay (s)	0.6	0.0	9.2
Approach LOS			A

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	17.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

27: 199th Street & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	60	20	10	5	20	50	10	230	10	30	60	30
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	67	22	11	6	22	56	11	258	11	34	67	34

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	101	84	281	135
Volume Left (vph)	67	6	11	34
Volume Right (vph)	11	56	11	34
Hadj (s)	0.13	-0.34	0.03	-0.07
Departure Headway (s)	5.1	4.7	4.6	4.6
Degree Utilization, x	0.14	0.11	0.36	0.17
Capacity (veh/h)	639	690	756	727
Control Delay (s)	9.0	8.3	10.1	8.6
Approach Delay (s)	9.0	8.3	10.1	8.6
Approach LOS	A	A	B	A

Intersection Summary			
Delay	9.3		
HCM Level of Service	A		
Intersection Capacity Utilization	37.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

30: US-56 & I-35 NB Loop

AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	360	1420	0	500	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	404	1596	0	562	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked						
vC, conflicting volume			2000		685	202
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			2000		685	202
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			291		386	811

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	202	202	1596	281	281
Volume Left	0	0	0	0	0
Volume Right	0	0	1596	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.12	0.12	0.94	0.17	0.17
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	91.3%	ICU Level of Service	F
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

80: 191st Street & Driveway A

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	10	5	95	75	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	11	5	103	82	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	109				79	57
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	109				79	57
tC, single (s)	5.1				7.4	7.2
tC, 2 stage (s)						
tF (s)	3.1				4.4	4.2
p0 queue free %	99				89	99
cM capacity (veh/h)	1043				726	790

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	16	109	82	5
Volume Left	5	0	82	0
Volume Right	0	103	0	5
cSH	1043	1700	726	790
Volume to Capacity	0.01	0.06	0.11	0.01
Queue Length 95th (ft)	0	0	9	1
Control Delay (s)	2.9	0.0	10.6	9.6
Lane LOS	A		B	A
Approach Delay (s)	2.9	0.0	10.5	
Approach LOS			B	

Intersection Summary			
Average Delay	4.5		
Intersection Capacity Utilization	17.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

81: 191st Street & Driveway B

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	110	70	90	10	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	120	76	98	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	174				255	125
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	174				255	125
tC, single (s)	4.5				7.0	6.6
tC, 2 stage (s)						
tF (s)	2.6				4.0	3.7
p0 queue free %	100				98	99
cM capacity (veh/h)	1203				621	833

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	125	174	11	5
Volume Left	5	0	11	0
Volume Right	0	98	0	5
cSH	1203	1700	621	833
Volume to Capacity	0.00	0.10	0.02	0.01
Queue Length 95th (ft)	0	0	1	0
Control Delay (s)	0.4	0.0	10.9	9.4
Lane LOS	A		B	A
Approach Delay (s)	0.4	0.0	10.4	
Approach LOS			B	

Intersection Summary			
Average Delay	0.7		
Intersection Capacity Utilization	19.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

82: Driveway C & Waverly Road

AM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	20	30	30	10	30	20
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	22	33	33	11	33	22
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	120	43	54			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	120	43	54			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	97	98			
cM capacity (veh/h)	863	1033	1564			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	22	33	43	54
Volume Left	22	0	33	0
Volume Right	0	33	0	22
cSH	863	1033	1564	1700
Volume to Capacity	0.03	0.03	0.02	0.03
Queue Length 95th (ft)	2	2	2	0
Control Delay (s)	9.3	8.6	5.6	0.0
Lane LOS	A	A	A	
Approach Delay (s)	8.9		5.6	0.0
Approach LOS	A			

Intersection Summary			
Average Delay	4.8		
Intersection Capacity Utilization	18.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

84: 191st Street & Driveway E

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	80	100	5	5	0
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	87	109	5	5	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	114				198	111
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	114				198	111
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	100
cM capacity (veh/h)	1488				795	947

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	87	114	5
Volume Left	0	0	5
Volume Right	0	5	0
cSH	1488	1700	795
Volume to Capacity	0.00	0.07	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	0.0	9.6
Lane LOS			A
Approach Delay (s)	0.0	0.0	9.6
Approach LOS			A

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	15.6%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Gardner IMF Operations + Induced Development - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
1: 175th Street & Waverly Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	90	5	5	280	80	10	20	5	30	20	20
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	12	108	6	6	337	96	12	24	6	36	24	24
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	434			114			569	581	111	551	536	386
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	434			114			569	581	111	551	536	386
tC, single (s)	4.1			4.1			7.2	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.6	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			100			97	94	99	91	95	96
cM capacity (veh/h)	1137			1487			385	421	947	417	447	667

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	127	440	42	84
Volume Left	12	6	12	36
Volume Right	6	96	6	24
cSH	1137	1487	445	477
Volume to Capacity	0.01	0.00	0.09	0.18
Queue Length 95th (ft)	1	0	8	16
Control Delay (s)	0.9	0.1	13.9	14.2
Lane LOS	A	A	B	B
Approach Delay (s)	0.9	0.1	13.9	14.2
Approach LOS			B	B

Intersection Summary			
Average Delay	2.8		
Intersection Capacity Utilization	33.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
2: US 56 & Gardner Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	270	50	210	630	220	60	150	140	140	150	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.98			0.97		1.00	0.93		1.00	0.97	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3273			3369		1770	1694		1736	1766	
Flt Permitted		0.81			0.77		0.62	1.00		0.44	1.00	
Satd. Flow (perm)		2664			2623		1158	1694		807	1766	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	34	310	57	241	724	253	69	172	161	161	172	46
RTOR Reduction (vph)	0	21	0	0	37	0	0	60	0	0	17	0
Lane Group Flow (vph)	0	380	0	0	1181	0	69	273	0	161	201	0
Heavy Vehicles (%)	3%	9%	2%	1%	4%	1%	2%	4%	4%	4%	4%	5%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		28.0			28.0		15.2	15.2		15.2	15.2	
Effective Green, g (s)		28.0			28.0		15.2	15.2		15.2	15.2	
Actuated g/C Ratio		0.51			0.51		0.28	0.28		0.28	0.28	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1359			1338		321	469		223	489	
v/s Ratio Prot								0.16			0.11	
v/s Ratio Perm		0.14			c0.45		0.06			c0.20		
v/c Ratio		0.28			0.88		0.21	0.58		0.72	0.41	
Uniform Delay, d1		7.7			12.0		15.3	17.1		17.9	16.2	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.1			7.2		0.3	1.8		10.9	0.6	
Delay (s)		7.8			19.2		15.6	19.0		28.9	16.8	
Level of Service		A			B		B	B		C	B	
Approach Delay (s)		7.8			19.2			18.4			21.9	
Approach LOS		A			B			B			C	

Intersection Summary			
HCM Average Control Delay	17.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	54.9	Sum of lost time (s)	11.7
Intersection Capacity Utilization	84.8%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
3: US 56 & Elm — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	570	20	30	1040	40	20	10	40	60	10	30
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		0.99			0.99			0.92			0.96	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3574			3668			1765			1842	
Flt Permitted		0.93			0.93			0.90			0.81	
Satd. Flow (perm)		3338			3412			1606			1544	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	11	613	22	32	1118	43	22	11	43	65	11	32
RTOR Reduction (vph)	0	2	0	0	3	0	0	36	0	0	27	0
Lane Group Flow (vph)	0	644	0	0	1190	0	0	40	0	0	81	0
Heavy Vehicles (%)	0%	6%	0%	3%	3%	0%	5%	0%	3%	2%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		33.0			33.0			8.2			8.2	
Effective Green, g (s)		33.0			33.0			8.2			8.2	
Actuated g/C Ratio		0.66			0.66			0.16			0.16	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2194			2243			262			252	
v/s Ratio Prot												
v/s Ratio Perm		0.19			c0.35			0.02			c0.05	
v/c Ratio		0.29			0.53			0.15			0.32	
Uniform Delay, d1		3.7			4.5			18.0			18.5	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.1			0.2			0.3			0.7	
Delay (s)		3.7			4.8			18.3			19.3	
Level of Service		A			A			B			B	
Approach Delay (s)		3.7			4.8			18.3			19.3	
Approach LOS		A			A			B			B	

Intersection Summary			
HCM Average Control Delay	5.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	50.2	Sum of lost time (s)	9.0
Intersection Capacity Utilization	67.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
4: US 56 & Mulberry — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	670	5	20	1130	30	10	5	20	40	10	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			1.00			0.92			0.98	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3436			3493			1678			1797	
Flt Permitted		0.93			0.94			0.89			0.78	
Satd. Flow (perm)		3213			3282			1509			1444	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	11	720	5	22	1215	32	11	5	22	43	11	11
RTOR Reduction (vph)	0	1	0	0	2	0	0	20	0	0	10	0
Lane Group Flow (vph)	0	735	0	0	1267	0	0	18	0	0	55	0
Heavy Vehicles (%)	0%	5%	0%	0%	3%	0%	0%	0%	5%	0%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		35.8			35.8			5.0			5.0	
Effective Green, g (s)		35.8			35.8			5.0			5.0	
Actuated g/C Ratio		0.72			0.72			0.10			0.10	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2310			2359			152			145	
v/s Ratio Prot												
v/s Ratio Perm		0.23			c0.39			0.01			c0.04	
v/c Ratio		0.32			0.54			0.12			0.38	
Uniform Delay, d1		2.6			3.2			20.4			21.0	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.1			0.2			0.4			1.7	
Delay (s)		2.6			3.4			20.8			22.6	
Level of Service		A			A			C			C	
Approach Delay (s)		2.6			3.4			20.8			22.6	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	4.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	49.8	Sum of lost time (s)	9.0
Intersection Capacity Utilization	60.9%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

2010 Gardner IMF Operations + Induced Development - PM Peak Hour - Synchro Intersection LOS

5: US 56 & Moonlight Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	120	400	220	170	940	520	130	160	50	250	210	100
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1736	3551	1583	1770	3539	1583	1770	3539	1583	3433	3539	1553
Flt Permitted	0.18	1.00	1.00	0.49	1.00	1.00	0.61	1.00	1.00	0.56	1.00	1.00
Satd. Flow (perm)	329	3551	1583	910	3539	1583	1132	3539	1583	2015	3539	1553
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	132	440	242	187	1033	571	143	176	55	275	231	110
RTOR Reduction (vph)	0	0	131	0	0	290	0	0	49	0	0	97
Lane Group Flow (vph)	132	440	111	187	1033	281	143	176	6	275	231	13
Heavy Vehicles (%)	4%	7%	2%	2%	2%	2%	2%	2%	2%	2%	2%	4%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6	8		8	4		4
Actuated Green, G (s)	47.5	41.4	41.4	47.5	41.4	41.4	18.1	9.4	9.4	20.9	10.8	10.8
Effective Green, g (s)	47.5	41.4	41.4	47.5	41.4	41.4	18.1	9.4	9.4	20.9	10.8	10.8
Actuated g/C Ratio	0.53	0.46	0.46	0.53	0.46	0.46	0.20	0.10	0.10	0.23	0.12	0.12
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	269	1633	728	539	1628	728	289	370	165	627	425	186
v/s Ratio Prot	c0.03	0.12		0.02	c0.29		0.05	0.05		c0.05	c0.07	
v/s Ratio Perm	0.23		0.07	0.16		0.18	0.05		0.00	0.05		0.01
v/c Ratio	0.49	0.27	0.15	0.35	0.63	0.39	0.49	0.48	0.03	0.44	0.54	0.07
Uniform Delay, d1	12.4	15.0	14.1	11.2	18.5	16.0	31.2	38.0	36.2	28.8	37.3	35.1
Progression Factor	1.00	1.00	1.00	1.42	1.32	3.69	1.18	1.13	1.39	1.00	1.00	1.00
Incremental Delay, d2	0.5	0.4	0.4	0.1	1.7	1.4	0.5	0.4	0.0	0.2	0.8	0.1
Delay (s)	13.0	15.4	14.6	16.0	26.2	60.2	37.3	43.1	50.3	29.0	38.0	35.2
Level of Service	B	B	B	B	C	E	D	D	D	C	D	D
Approach Delay (s)		14.7			36.0			41.9			33.5	
Approach LOS		B			D			D			C	

Intersection Summary			
HCM Average Control Delay	31.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	17.5
Intersection Capacity Utilization	65.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

6: Old US 56 & US 56

PM Peak Hour

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	110	20	600	100	10	1520
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	4.0	5.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1736	1538	3619	1553	1805	3725
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1736	1538	3619	1553	1805	3725
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	113	21	619	103	10	1567
RTOR Reduction (vph)	0	19	0	86	0	0
Lane Group Flow (vph)	113	2	619	17	10	1567
Heavy Vehicles (%)	4%	5%	5%	4%	0%	2%
Turn Type		Perm		custom	Prot	
Protected Phases	8		2	4	1	6
Permitted Phases		8				
Actuated Green, G (s)	9.8	9.8	64.8	9.8	1.4	70.2
Effective Green, g (s)	9.8	9.8	64.8	9.8	1.4	70.2
Actuated g/C Ratio	0.11	0.11	0.72	0.11	0.02	0.78
Clearance Time (s)	5.0	5.0	5.0	5.0	4.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	189	167	2606	169	28	2906
v/s Ratio Prot	c0.07		0.17	0.01	0.01	c0.42
v/s Ratio Perm		0.00				
v/c Ratio	0.60	0.01	0.24	0.10	0.36	0.54
Uniform Delay, d1	38.2	35.8	4.3	36.1	43.9	3.8
Progression Factor	1.00	1.00	0.58	2.05	1.00	1.00
Incremental Delay, d2	5.0	0.0	0.2	0.3	7.7	0.7
Delay (s)	43.2	35.8	2.7	74.4	51.5	4.5
Level of Service	D	D	A	E	D	A
Approach Delay (s)	42.1		12.9			4.8
Approach LOS	D		B			A

Intersection Summary			
HCM Average Control Delay	9.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	54.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

7: US-56 & Cedar Niles

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	1140	160	450	1180	30	120	10	350	30	10	20
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00		1.00	0.88	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85	1.00	0.90	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1805	3689	1599	3502	3689	1615		1816	2842	1805	1710	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.72	1.00	0.62	1.00	
Satd. Flow (perm)	1805	3689	1599	3502	3689	1615		1364	2842	1171	1710	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	45	1281	180	506	1326	34	135	11	393	34	11	22
RTOR Reduction (vph)	0	0	92	0	0	14	0	0	336	0	19	0
Lane Group Flow (vph)	45	1281	88	506	1326	20	0	146	57	34	14	0
Heavy Vehicles (%)	0%	3%	1%	0%	3%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Prot		Perm	Prot		Perm	Perm		Perm	Perm		
Protected Phases	5	2		1	6			8			4	
Permitted Phases			2			6	8		8	4		
Actuated Green, G (s)	4.8	39.0	39.0	13.8	48.0	48.0		11.6	11.6	11.6	11.6	
Effective Green, g (s)	4.8	39.0	39.0	13.8	48.0	48.0		11.6	11.6	11.6	11.6	
Actuated g/C Ratio	0.06	0.49	0.49	0.17	0.60	0.60		0.14	0.14	0.14	0.14	
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0	
Lane Grp Cap (vph)	108	1798	780	604	2213	969		198	412	170	248	
v/s Ratio Prot	0.02	c0.35		c0.14	0.36						0.01	
v/s Ratio Perm			0.05			0.01		c0.11	0.02	0.03		
v/c Ratio	0.42	0.71	0.11	0.84	0.60	0.02		0.74	0.14	0.20	0.06	
Uniform Delay, d1	36.3	16.1	11.1	32.0	10.0	6.5		32.7	29.8	30.1	29.5	
Progression Factor	1.00	1.00	1.00	0.83	1.32	2.10		1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.9	2.4	0.3	6.3	0.8	0.0		11.6	0.1	0.2	0.0	
Delay (s)	37.2	18.5	11.4	32.8	13.9	13.6		44.4	29.9	30.3	29.5	
Level of Service	D	B	B	C	B	B		D	C	C	C	
Approach Delay (s)		18.2			19.1			33.8			29.9	
Approach LOS		B			B			C			C	

Intersection Summary			
HCM Average Control Delay	20.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	15.6
Intersection Capacity Utilization	69.6%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

8: US-56 & I-35 SB Ramps

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1320	210	110	460	0	0	0	0	120	0	1200
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					2.5		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		0.98		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3437		1703	3725					1770		2760
Flt Permitted		1.00		0.95	1.00					0.95		1.00
Satd. Flow (perm)		3437		1703	3725					1770		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1389	221	116	484	0	0	0	0	126	0	1263
RTOR Reduction (vph)	0	14	0	0	0	0	0	0	0	0	0	114
Lane Group Flow (vph)	0	1596	0	116	484	0	0	0	0	126	0	1149
Heavy Vehicles (%)	0%	3%	2%	6%	2%	0%	0%	0%	0%	2%	0%	3%
Turn Type				Prot						Prot		custom
Protected Phases		2		1	6					7		5
Permitted Phases												4
Actuated Green, G (s)		52.1		7.8	23.9					7.6		36.0
Effective Green, g (s)		52.1		7.8	23.9					7.6		36.0
Actuated g/C Ratio		0.65		0.10	0.30					0.10		0.45
Clearance Time (s)		5.0		5.0	5.0					2.5		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2238		166	1113					168		1242
v/s Ratio Prot		c0.46		c0.07	0.13					c0.07		c0.42
v/s Ratio Perm												
v/c Ratio		0.71		0.70	0.43					0.75		0.92
Uniform Delay, d1		9.1		35.0	22.6					35.3		20.7
Progression Factor		0.44		1.04	0.82					1.00		1.00
Incremental Delay, d2		1.5		11.3	1.1					17.0		11.6
Delay (s)		5.4		47.7	19.7					52.3		32.3
Level of Service		A		D	B					D		C
Approach Delay (s)		5.4			25.1			0.0			34.1	
Approach LOS		A			C			A			C	

Intersection Summary			
HCM Average Control Delay	19.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	17.5
Intersection Capacity Utilization	67.6%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

9: US-56 & I-35 NB Ramps

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	460	0	0	490	20	80	0	40	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			0.99			0.96				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3762			1830			1597				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3762			1830			1597				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	523	0	0	557	23	91	0	45	0	0	0
RTOR Reduction (vph)	0	0	0	0	1	0	0	25	0	0	0	0
Lane Group Flow (vph)	0	523	0	0	579	0	0	111	0	0	0	0
Heavy Vehicles (%)	0%	1%	0%	0%	3%	10%	6%	0%	18%	0%	0%	0%
Turn Type							Perm					
Protected Phases		2			6			8				
Permitted Phases							8					
Actuated Green, G (s)		59.0			59.0			11.0				
Effective Green, g (s)		59.0			59.0			11.0				
Actuated g/C Ratio		0.74			0.74			0.14				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		2774			1350			220				
v/s Ratio Prot		0.14			c0.32							
v/s Ratio Perm								0.07				
v/c Ratio		0.19			0.43			0.50				
Uniform Delay, d1		3.2			4.0			32.0				
Progression Factor		0.31			1.00			1.00				
Incremental Delay, d2		0.1			1.0			1.8				
Delay (s)		1.1			5.0			33.8				
Level of Service		A			A			C				
Approach Delay (s)		1.1			5.0			33.8			0.0	
Approach LOS		A			A			C			A	

Intersection Summary			
HCM Average Control Delay	6.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

10: Sante Fe & Moonlight Drive

PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	90	110	240	60	140	460
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.97		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3432		1770	3539
Flt Permitted	0.95	1.00	1.00		0.56	1.00
Satd. Flow (perm)	1770	1583	3432		1036	3539
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	97	118	258	65	151	495
RTOR Reduction (vph)	0	104	14	0	0	0
Lane Group Flow (vph)	97	14	309	0	151	495
Turn Type		Perm			Perm	
Protected Phases	6		8			4
Permitted Phases		6			4	
Actuated Green, G (s)	10.4	10.4	69.6		69.6	69.6
Effective Green, g (s)	10.4	10.4	69.6		69.6	69.6
Actuated g/C Ratio	0.12	0.12	0.77		0.77	0.77
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	205	183	2654		801	2737
v/s Ratio Prot	c0.05		0.09			0.14
v/s Ratio Perm		0.01			c0.15	
v/c Ratio	0.47	0.07	0.12		0.19	0.18
Uniform Delay, d1	37.2	35.5	2.5		2.7	2.7
Progression Factor	1.00	1.00	1.00		0.43	0.46
Incremental Delay, d2	1.7	0.2	0.1		0.5	0.1
Delay (s)	39.0	35.7	2.6		1.7	1.4
Level of Service	D	D	A		A	A
Approach Delay (s)	37.2		2.6			1.4
Approach LOS	D		A			A

Intersection Summary			
HCM Average Control Delay	8.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.23		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	34.6%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

11: Waverly Road & US 56

PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	20	20	10	10	10	20	120	0	20	260	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	25	25	13	13	13	25	152	0	25	329	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	604	589	152	623	585	332	335			152		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	604	589	152	623	585	332	335			152		
tC, single (s)	7.1	6.6	6.4	7.2	6.6	6.3	4.1			4.3		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.4	3.6	4.1	3.4	2.2			2.4		
p0 queue free %	100	94	97	96	97	98	98			98		
cM capacity (veh/h)	384	401	861	347	396	691	1235			1326		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	51	38	177	361
Volume Left	0	13	25	25
Volume Right	25	13	0	6
cSH	547	438	1235	1326
Volume to Capacity	0.09	0.09	0.02	0.02
Queue Length 95th (ft)	8	7	2	1
Control Delay (s)	12.3	14.0	1.3	0.7
Lane LOS	B	B	A	A
Approach Delay (s)	12.3	14.0	1.3	0.7
Approach LOS	B	B		

Intersection Summary			
Average Delay	2.6		
Intersection Capacity Utilization	32.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

12: 183rd Street & Four Corners Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	5	5	0	5	5	5	5	0	5	5	5
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	5	0	5	5	5	5	0	5	5	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	16	11	11	16
Volume Left (vph)	5	0	5	5
Volume Right (vph)	5	5	0	5
Hadj (s)	-0.13	-0.30	0.10	-0.13
Departure Headway (s)	3.8	3.7	4.1	3.8
Degree Utilization, x	0.02	0.01	0.01	0.02
Capacity (veh/h)	925	967	865	927
Control Delay (s)	6.9	6.7	7.1	6.9
Approach Delay (s)	6.9	6.7	7.1	6.9
Approach LOS	A	A	A	A

Intersection Summary			
Delay	6.9		
HCM Level of Service	A		
Intersection Capacity Utilization	15.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
13: 183rd Street & US 56 — PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	5	0	0	140	270	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	0	0	177	342	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	519	342	342			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	519	342	342			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	99	100	100			
cM capacity (veh/h)	521	705	1229			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	6	177	342
Volume Left	6	0	0
Volume Right	0	0	0
cSH	521	1229	1700
Volume to Capacity	0.01	0.00	0.20
Queue Length 95th (ft)	1	0	0
Control Delay (s)	12.0	0.0	0.0
Lane LOS	B		
Approach Delay (s)	12.0	0.0	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	24.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
14: 183rd Street & Waverly Road — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	5	10	20	5	5	20
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	11	22	5	5	22
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	57	24			27	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	57	24			27	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	99			100	
cM capacity (veh/h)	952	1058			1600	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	16	27	27
Volume Left	5	0	5
Volume Right	11	5	0
cSH	1020	1700	1600
Volume to Capacity	0.02	0.02	0.00
Queue Length 95th (ft)	1	0	0
Control Delay (s)	8.6	0.0	1.5
Lane LOS	A		A
Approach Delay (s)	8.6	0.0	1.5
Approach LOS	A		

Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	15.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
15: 183rd Street & Gardner Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	20	30	50	30	40	70	270	110	60	240	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.91		1.00	0.91		1.00	0.96		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1752	1696		1770	1687		1787	3316		1770	3401	
Flt Permitted	0.89	1.00		0.89	1.00		0.56	1.00		0.50	1.00	
Satd. Flow (perm)	1640	1696		1656	1687		1055	3316		937	3401	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	34	22	34	56	34	45	79	303	124	67	270	45
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	34	56	0	56	79	0	79	427	0	67	315	0
Heavy Vehicles (%)	3%	0%	3%	2%	3%	3%	1%	5%	2%	2%	4%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	4.5	4.5		4.5	4.5		15.3	15.3		15.3	15.3	
Effective Green, g (s)	4.5	4.5		4.5	4.5		15.3	15.3		15.3	15.3	
Actuated g/C Ratio	0.15	0.15		0.15	0.15		0.51	0.51		0.51	0.51	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	248	256		250	255		542	1703		481	1746	
v/s Ratio Prot		0.03			c0.05			c0.13			0.09	
v/s Ratio Perm	0.02			0.03			0.07			0.07		
v/c Ratio	0.14	0.22		0.22	0.31		0.15	0.25		0.14	0.18	
Uniform Delay, d1	11.0	11.1		11.1	11.3		3.8	4.0		3.8	3.9	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.3	0.4		0.5	0.7		0.1	0.1		0.1	0.0	
Delay (s)	11.2	11.5		11.6	12.0		3.9	4.1		3.9	3.9	
Level of Service	B	B		B	B		A	A		A	A	
Approach Delay (s)		11.4			11.8			4.1			3.9	
Approach LOS		B			B			A			A	

Intersection Summary			
HCM Average Control Delay	5.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.26		
Actuated Cycle Length (s)	29.8	Sum of lost time (s)	10.0
Intersection Capacity Utilization	38.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
16: Four Corners Road & US 56 — PM Peak Hour

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	0	5	5	150	280	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	0	7	7	197	368	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	579	368	368			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	579	368	368			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	99	99			
cM capacity (veh/h)	478	682	1201			

Direction, Lane #	SB 1	NE 1	SW 1
Volume Total	7	204	368
Volume Left	0	7	0
Volume Right	7	0	0
cSH	682	1201	1700
Volume to Capacity	0.01	0.01	0.22
Queue Length 95th (ft)	1	0	0
Control Delay (s)	10.3	0.3	0.0
Lane LOS	B	A	
Approach Delay (s)	10.3	0.3	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.2		
Intersection Capacity Utilization	24.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

17: 191st Street & US 56

PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	5	5	0	150	280	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	6	6	0	195	364	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	562	367	370			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	562	367	370			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	99	99	100			
cM capacity (veh/h)	492	683	1199			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	13	195	370
Volume Left	6	0	0
Volume Right	6	0	6
cSH	572	1199	1700
Volume to Capacity	0.02	0.00	0.22
Queue Length 95th (ft)	2	0	0
Control Delay (s)	11.4	0.0	0.0
Lane LOS	B		
Approach Delay (s)	11.4	0.0	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	25.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

19: 191st Street & Waverly Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	20	140	0	5	150	10	5	5	5	10	5	20
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	22	152	0	5	163	11	5	5	5	11	5	22
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	174			152			399	380	152	383	375	168
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	174			152			399	380	152	383	375	168
tC, single (s)	4.3			4.1			7.1	6.5	6.2	7.1	6.5	6.4
tC, 2 stage (s)												
tF (s)	2.4			2.2			3.5	4.0	3.3	3.5	4.0	3.5
p0 queue free %	98			100			99	99	99	98	99	97
cM capacity (veh/h)	1301			1441			537	544	899	562	548	819

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	174	179	16	38
Volume Left	22	5	5	11
Volume Right	0	11	5	22
cSH	1301	1441	623	682
Volume to Capacity	0.02	0.00	0.03	0.06
Queue Length 95th (ft)	1	0	2	4
Control Delay (s)	1.1	0.3	10.9	10.6
Lane LOS	A	A	B	B
Approach Delay (s)	1.1	0.3	10.9	10.6
Approach LOS			B	B

Intersection Summary			
Average Delay	2.0		
Intersection Capacity Utilization	26.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

20: W 191st Street & Gardner Rd

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	5	160	20	5	20	160	510	20	20	380	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00			0.95			0.95	1.00
Frt	1.00	1.00	0.85		0.94			1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00		0.98			0.99			1.00	1.00
Satd. Flow (prot)	1805	1900	1091		1746			3028			3501	1468
Flt Permitted	0.73	1.00	1.00		0.86			0.74			0.91	1.00
Satd. Flow (perm)	1378	1900	1091		1528			2266			3180	1468
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	11	5	168	22	5	22	168	537	22	22	400	11
RTOR Reduction (vph)	0	0	150	0	20	0	0	1	0	0	0	2
Lane Group Flow (vph)	11	5	18	0	29	0	0	726	0	0	422	9
Heavy Vehicles (%)	0%	0%	48%	0%	0%	0%	59%	5%	0%	0%	3%	10%
Turn Type	Perm		Perm	Perm			Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	9.1	9.1	9.1		9.1			65.9			65.9	65.9
Effective Green, g (s)	9.1	9.1	9.1		9.1			65.9			65.9	65.9
Actuated g/C Ratio	0.11	0.11	0.11		0.11			0.78			0.78	0.78
Clearance Time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	148	203	117		164			1757			2465	1138
v/s Ratio Prot		0.00										
v/s Ratio Perm	0.01		0.02		c0.02			c0.32			0.13	0.01
v/c Ratio	0.07	0.02	0.15		0.18			0.41			0.17	0.01
Uniform Delay, d1	34.2	34.0	34.5		34.5			3.2			2.5	2.2
Progression Factor	1.00	1.00	1.00		1.00			0.92			1.00	1.00
Incremental Delay, d2	0.2	0.0	0.6		0.5			0.6			0.2	0.0
Delay (s)	34.4	34.0	35.1		35.1			3.5			2.6	2.2
Level of Service	C	C	D		D			A			A	A
Approach Delay (s)		35.0			35.1			3.5			2.6	
Approach LOS		C			D			A			A	

Intersection Summary			
HCM Average Control Delay	8.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	52.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects

21: I-35 SB Ramps & Gardner Rd

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	150	0	520	10	160	0	0	470	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0		5.0		5.0			5.0	5.0
Lane Util. Factor				1.00		1.00		1.00			1.00	1.00
Frt				1.00		0.85		1.00			1.00	0.85
Flt Protected				0.95		1.00		1.00			1.00	1.00
Satd. Flow (prot)				1752		1335		1783			1610	1495
Flt Permitted				0.95		1.00		0.97			1.00	1.00
Satd. Flow (perm)				1752		1335		1737			1610	1495
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	160	0	553	11	170	0	0	500	96
RTOR Reduction (vph)	0	0	0	0	0	452	0	0	0	0	0	29
Lane Group Flow (vph)	0	0	0	160	0	101	0	181	0	0	500	67
Heavy Vehicles (%)	0%	0%	0%	3%	0%	21%	10%	6%	0%	0%	18%	8%
Turn Type				Prot		custom	Perm					Perm
Protected Phases				3				2			6	
Permitted Phases						3	2					6
Actuated Green, G (s)				15.6		15.6		59.4			59.4	59.4
Effective Green, g (s)				15.6		15.6		59.4			59.4	59.4
Actuated g/C Ratio				0.18		0.18		0.70			0.70	0.70
Clearance Time (s)				5.0		5.0		5.0			5.0	5.0
Vehicle Extension (s)				3.0		3.0		3.0			3.0	3.0
Lane Grp Cap (vph)				322		245		1214			1125	1045
v/s Ratio Prot				c0.09							c0.31	
v/s Ratio Perm						0.08		0.10				0.04
v/c Ratio				0.50		0.41		0.15			0.44	0.06
Uniform Delay, d1				31.2		30.7		4.3			5.6	4.0
Progression Factor				1.00		1.00		0.75			0.88	0.69
Incremental Delay, d2				1.2		1.1		0.3			1.3	0.1
Delay (s)				32.4		31.8		3.5			6.2	2.9
Level of Service				C		C		A			A	A
Approach Delay (s)		0.0			31.9			3.5			5.7	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM Average Control Delay	18.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.46		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	49.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
22: I-35 NB Ramps & Gardner Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	0	20	0	0	0	0	120	40	330	280	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.96						0.97			1.00	
Flt Protected		0.97						1.00			0.97	
Satd. Flow (prot)		1603						1774			1615	
Flt Permitted		0.97						1.00			0.74	
Satd. Flow (perm)		1603						1774			1224	
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	55	0	22	0	0	0	0	132	44	363	308	0
RTOR Reduction (vph)	0	18	0	0	0	0	0	8	0	0	0	0
Lane Group Flow (vph)	0	59	0	0	0	0	0	168	0	0	671	0
Heavy Vehicles (%)	12%	0%	5%	0%	0%	0%	0%	3%	5%	26%	1%	0%
Turn Type	Perm									Perm		
Protected Phases		4						2			6	
Permitted Phases	4									6		
Actuated Green, G (s)		6.2						68.8			68.8	
Effective Green, g (s)		6.2						68.8			68.8	
Actuated g/C Ratio		0.07						0.81			0.81	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		117						1436			991	
v/s Ratio Prot								0.09				
v/s Ratio Perm		0.04									c0.55	
v/c Ratio		0.51						0.12			0.68	
Uniform Delay, d1		37.9						1.7			3.4	
Progression Factor		1.00						1.00			0.90	
Incremental Delay, d2		3.4						0.2			3.5	
Delay (s)		41.4						1.9			6.6	
Level of Service		D						A			A	
Approach Delay (s)		41.4			0.0			1.9			6.6	
Approach LOS		D			A			A			A	

Intersection Summary			
HCM Average Control Delay	8.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	60.1%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
23: E 191st Street & Gardner Rd — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	5	160	5	10	290
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	5	172	5	11	312
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						220
pX, platoon unblocked						
vC, conflicting volume	508	175			177	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	508	175			177	
tC, single (s)	6.4	6.4			4.2	
tC, 2 stage (s)						
tF (s)	3.5	3.5			2.3	
p0 queue free %	100	99			99	
cM capacity (veh/h)	524	824			1352	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	5	177	323
Volume Left	0	0	11
Volume Right	5	5	0
cSH	824	1700	1352
Volume to Capacity	0.01	0.10	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	9.4	0.0	0.3
Lane LOS	A		A
Approach Delay (s)	9.4	0.0	0.3
Approach LOS	A		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	33.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
24: Sunflower Road & US 56 — PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	5	10	30	5	0	10	150	40	0	290	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	6	13	38	6	0	13	190	51	0	367	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	614	636	370	627	614	215	373			241		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	614	636	370	627	614	215	373			241		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	100	98	98	90	98	100	99			100		
cM capacity (veh/h)	399	394	680	370	405	830	1196			1338		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	19	44	253	373
Volume Left	0	38	13	0
Volume Right	13	0	51	6
cSH	547	375	1196	1338
Volume to Capacity	0.03	0.12	0.01	0.00
Queue Length 95th (ft)	3	10	1	0
Control Delay (s)	11.8	15.9	0.5	0.0
Lane LOS	B	C	A	
Approach Delay (s)	11.8	15.9	0.5	0.0
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	34.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
25: US 56 & 4th Street — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	170	20	30	310	60	20
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	218	26	38	397	77	26
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			244		705	231
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			244		705	231
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		80	97
cM capacity (veh/h)			1335		391	813

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	244	436	103
Volume Left	0	38	77
Volume Right	26	0	26
cSH	1700	1335	449
Volume to Capacity	0.14	0.03	0.23
Queue Length 95th (ft)	0	2	22
Control Delay (s)	0.0	1.0	15.4
Lane LOS		A	C
Approach Delay (s)	0.0	1.0	15.4
Approach LOS			C

Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	42.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
26: 199th Street & Four Corners Road — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	30	40	5	10	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	12	36	48	6	12	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	54				110	51
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	54				110	51
tC, single (s)	4.3				6.5	6.6
tC, 2 stage (s)						
tF (s)	2.4				3.6	3.7
p0 queue free %	99				99	99
cM capacity (veh/h)	1444				861	920

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	48	54	18
Volume Left	12	0	12
Volume Right	0	6	6
cSH	1444	1700	880
Volume to Capacity	0.01	0.03	0.02
Queue Length 95th (ft)	1	0	2
Control Delay (s)	1.9	0.0	9.2
Lane LOS	A		A
Approach Delay (s)	1.9	0.0	9.2
Approach LOS			A

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	18.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
27: 199th Street & Gardner Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	20	20	10	30	40	10	80	10	40	170	40
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	22	22	22	11	34	45	11	90	11	45	191	45

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	67	90	112	281
Volume Left (vph)	22	11	11	45
Volume Right (vph)	22	45	11	45
Hadj (s)	-0.11	-0.19	0.01	-0.02
Departure Headway (s)	4.8	4.7	4.6	4.4
Degree Utilization, x	0.09	0.12	0.14	0.34
Capacity (veh/h)	678	696	737	784
Control Delay (s)	8.3	8.3	8.4	9.7
Approach Delay (s)	8.3	8.3	8.4	9.7
Approach LOS	A	A	A	A

Intersection Summary			
Delay	9.0		
HCM Level of Service	A		
Intersection Capacity Utilization	34.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
30: US-56 & I-35 NB Loop — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	460	980	0	570	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	517	1101	0	640	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked						
vC, conflicting volume			1618		837	258
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1618		837	258
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			408		309	747

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	258	258	1101	320	320
Volume Left	0	0	0	0	0
Volume Right	0	0	1101	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.15	0.15	0.65	0.19	0.19
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	64.0%	ICU Level of Service	C
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
80: 191st Street & Driveway A — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	5	5	95	75	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	5	103	82	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	109				73	57
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	109				73	57
tC, single (s)	5.1				7.4	7.2
tC, 2 stage (s)						
tF (s)	3.1				4.4	4.2
p0 queue free %	99				89	99
cM capacity (veh/h)	1043				732	790

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	11	109	82	5
Volume Left	5	0	82	0
Volume Right	0	103	0	5
cSH	1043	1700	732	790
Volume to Capacity	0.01	0.06	0.11	0.01
Queue Length 95th (ft)	0	0	9	1
Control Delay (s)	4.3	0.0	10.5	9.6
Lane LOS	A		B	A
Approach Delay (s)	4.3	0.0	10.5	
Approach LOS			B	

Intersection Summary			
Average Delay	4.6		
Intersection Capacity Utilization	17.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
81: 191st Street & Driveway B — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	80	100	70	80	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	87	109	76	87	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	185				255	147
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	185				255	147
tC, single (s)	4.5				6.5	6.6
tC, 2 stage (s)						
tF (s)	2.6				3.6	3.7
p0 queue free %	99				88	99
cM capacity (veh/h)	1191				718	809

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	98	185	87	11
Volume Left	11	0	87	0
Volume Right	0	76	0	11
cSH	1191	1700	718	809
Volume to Capacity	0.01	0.11	0.12	0.01
Queue Length 95th (ft)	1	0	10	1
Control Delay (s)	1.0	0.0	10.7	9.5
Lane LOS	A		B	A
Approach Delay (s)	1.0	0.0	10.6	
Approach LOS			B	

Intersection Summary			
Average Delay	3.0		
Intersection Capacity Utilization	23.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
82: Driveway C & Waverly Road — PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	5	5	5	20	20	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	5	22	22	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	57	24	27			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	57	24	27			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	99	99	100			
cM capacity (veh/h)	952	1058	1600			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	5	5	27	27
Volume Left	5	0	5	0
Volume Right	0	5	0	5
cSH	952	1058	1600	1700
Volume to Capacity	0.01	0.01	0.00	0.02
Queue Length 95th (ft)	0	0	0	0
Control Delay (s)	8.8	8.4	1.5	0.0
Lane LOS	A	A	A	
Approach Delay (s)	8.6		1.5	0.0
Approach LOS	A			

Intersection Summary			
Average Delay	2.0		
Intersection Capacity Utilization	15.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Gardner Proposed Action + Indirect Effects
84: 191st Street & Driveway E — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	80	100	5	5	0
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	87	109	5	5	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	114				198	111
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	114				198	111
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	100
cM capacity (veh/h)	1488				795	947

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	87	114	5
Volume Left	0	0	5
Volume Right	0	5	0
cSH	1488	1700	795
Volume to Capacity	0.00	0.07	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	0.0	9.6
Lane LOS			A
Approach Delay (s)	0.0	0.0	9.6
Approach LOS			A

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	15.6%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Gardner IMF Operations + Induced Development - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

1: 175th Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	70	330	20	0	60	60	10	100	5	100	50	20
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	84	398	24	0	72	72	12	120	6	120	60	24

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	506	145	139	205
Volume Left (vph)	84	0	12	120
Volume Right (vph)	24	72	6	24
Hadj (s)	0.07	-0.23	0.04	0.12
Departure Headway (s)	5.3	5.6	6.2	6.1
Degree Utilization, x	0.75	0.22	0.24	0.35
Capacity (veh/h)	658	574	507	531
Control Delay (s)	22.1	10.2	11.1	12.3
Approach Delay (s)	22.1	10.2	11.1	12.3
Approach LOS	C	B	B	B

Intersection Summary			
Delay	16.8		
HCM Level of Service	C		
Intersection Capacity Utilization	51.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

2: US 56 & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	670	70	110	390	120	80	370	220	160	240	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.99			0.97		1.00	0.94		1.00	0.97	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3341			3234		1805	1725		1736	1779	
Flt Permitted		0.82			0.56		0.50	1.00		0.20	1.00	
Satd. Flow (perm)		2760			1829		943	1725		358	1779	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	57	770	80	126	448	138	92	425	253	184	276	69
RTOR Reduction (vph)	0	9	0	0	28	0	0	29	0	0	12	0
Lane Group Flow (vph)	0	898	0	0	684	0	92	649	0	184	333	0
Heavy Vehicles (%)	4%	7%	1%	7%	8%	6%	0%	4%	4%	4%	4%	2%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		28.1			28.1		35.2	35.2		35.2	35.2	
Effective Green, g (s)		28.1			28.1		35.2	35.2		35.2	35.2	
Actuated g/C Ratio		0.37			0.37		0.47	0.47		0.47	0.47	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1034			685		443	810		168	835	
v/s Ratio Prot								0.38			0.19	
v/s Ratio Perm		0.33			c0.37		0.10			c0.51		
v/c Ratio		0.87			1.00		0.21	0.80		1.10	0.40	
Uniform Delay, d1		21.7			23.4		11.7	16.9		19.9	13.0	
Progression Factor		1.00			0.40		1.00	1.00		1.00	1.00	
Incremental Delay, d2		9.8			33.7		0.2	5.7		97.2	0.3	
Delay (s)		31.6			43.1		11.9	22.7		117.1	13.3	
Level of Service		C			D		B	C		F	B	
Approach Delay (s)		31.6			43.1			21.4			49.4	
Approach LOS		C			D			C			D	

Intersection Summary			
HCM Average Control Delay	34.9	HCM Level of Service	C
HCM Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	11.7
Intersection Capacity Utilization	101.3%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

3: US 56 & Elm

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	1030	10	10	580	50	10	5	30	80	10	30
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			0.99			0.91			0.97	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3582			3499			1799			1857	
Flt Permitted		0.94			0.94			0.94			0.81	
Satd. Flow (perm)		3357			3275			1714			1559	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	22	1108	11	11	624	54	11	5	32	86	11	32
RTOR Reduction (vph)	0	0	0	0	5	0	0	28	0	0	21	0
Lane Group Flow (vph)	0	1141	0	0	684	0	0	20	0	0	108	0
Heavy Vehicles (%)	0%	6%	0%	0%	8%	0%	0%	0%	0%	0%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		56.3			56.3			9.7			9.7	
Effective Green, g (s)		56.3			56.3			9.7			9.7	
Actuated g/C Ratio		0.75			0.75			0.13			0.13	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2520			2458			222			202	
v/s Ratio Prot												
v/s Ratio Perm		c0.34			0.21			0.01			c0.07	
v/c Ratio		0.45			0.28			0.09			0.54	
Uniform Delay, d1		3.5			2.9			28.8			30.5	
Progression Factor		0.45			0.81			1.00			1.00	
Incremental Delay, d2		0.3			0.1			0.2			2.7	
Delay (s)		1.9			2.5			28.9			33.3	
Level of Service		A			A			C			C	
Approach Delay (s)		1.9			2.5			28.9			33.3	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	4.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.46		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	61.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

4: US 56 & Mulberry

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	1120	10	10	580	60	5	5	20	100	5	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			0.99			0.91			0.97	
Flt Protected		1.00			1.00			0.99			0.96	
Satd. Flow (prot)		3429			3297			1605			1740	
Flt Permitted		0.91			0.93			0.95			0.76	
Satd. Flow (perm)		3123			3077			1545			1372	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	43	1204	11	11	624	65	5	5	22	108	5	32
RTOR Reduction (vph)	0	1	0	0	9	0	0	19	0	0	14	0
Lane Group Flow (vph)	0	1257	0	0	691	0	0	13	0	0	131	0
Heavy Vehicles (%)	5%	5%	0%	0%	8%	8%	0%	20%	5%	2%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		54.1			54.1			11.9			11.9	
Effective Green, g (s)		54.1			54.1			11.9			11.9	
Actuated g/C Ratio		0.72			0.72			0.16			0.16	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2253			2220			245			218	
v/s Ratio Prot												
v/s Ratio Perm		c0.40			0.22			0.01			c0.10	
v/c Ratio		0.56			0.31			0.06			0.60	
Uniform Delay, d1		4.9			3.8			26.8			29.3	
Progression Factor		0.79			0.66			1.00			1.00	
Incremental Delay, d2		0.9			0.1			0.1			4.4	
Delay (s)		4.8			2.6			26.9			33.7	
Level of Service		A			A			C			C	
Approach Delay (s)		4.8			2.6			26.9			33.7	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	6.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	82.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

5: US 56 & Moonlight Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↑	↱	↰	↑↑	↱	↰↰	↑↑	↱
Volume (vph)	80	1070	150	40	460	180	150	130	130	490	170	60
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1719	3585	1568	1752	3312	1583	1770	3539	1538	3433	3505	1538
Flt Permitted	0.42	1.00	1.00	0.15	1.00	1.00	0.63	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	751	3585	1568	276	3312	1583	1181	3539	1538	3433	3505	1538
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	88	1176	165	44	505	198	165	143	143	538	187	66
RTOR Reduction (vph)	0	0	104	0	0	128	0	0	128	0	0	56
Lane Group Flow (vph)	88	1176	61	44	505	70	165	143	15	538	187	10
Heavy Vehicles (%)	5%	6%	3%	3%	9%	2%	2%	2%	5%	2%	3%	5%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	Prot		Perm
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6	8		8			4
Actuated Green, G (s)	32.7	27.9	27.9	30.3	26.7	26.7	16.7	8.0	8.0	12.5	11.8	11.8
Effective Green, g (s)	32.7	27.9	27.9	30.3	26.7	26.7	16.7	8.0	8.0	12.5	11.8	11.8
Actuated g/C Ratio	0.44	0.37	0.37	0.40	0.36	0.36	0.22	0.11	0.11	0.17	0.16	0.16
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	389	1334	583	182	1179	564	331	377	164	572	551	242
v/s Ratio Prot	c0.01	c0.33		0.01	0.15		0.06	0.04		c0.16	c0.05	
v/s Ratio Perm	0.08		0.04	0.09		0.04	c0.05		0.01			0.01
v/c Ratio	0.23	0.88	0.11	0.24	0.43	0.12	0.50	0.38	0.09	0.94	0.34	0.04
Uniform Delay, d1	12.6	22.0	15.4	15.7	18.4	16.3	25.0	31.2	30.2	30.9	28.1	26.8
Progression Factor	0.51	0.63	0.44	0.71	0.96	1.66	0.95	0.92	0.75	1.00	1.00	1.00
Incremental Delay, d2	0.1	7.7	0.3	0.2	1.1	0.4	0.4	0.2	0.1	23.6	0.1	0.0
Delay (s)	6.6	21.5	7.0	11.4	18.7	27.4	24.1	29.1	22.9	54.5	28.3	26.8
Level of Service	A	C	A	B	B	C	C	C	C	D	C	C
Approach Delay (s)		18.9			20.6			25.3			46.0	
Approach LOS		B			C			C			D	

Intersection Summary			
HCM Average Control Delay	26.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	72.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

6: Old US 56 & US 56 — AM Peak Hour

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations	↰	↱	↑↑	↱	↰	↑↑
Volume (vph)	60	10	1450	240	10	650
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	4.0	5.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1615	3619	1568	1805	3551
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1615	3619	1568	1805	3551
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	62	10	1495	247	10	670
RTOR Reduction (vph)	0	8	0	94	0	0
Lane Group Flow (vph)	62	2	1495	153	10	670
Heavy Vehicles (%)	2%	0%	5%	3%	0%	7%
Turn Type		Perm		custom	Prot	
Protected Phases	8		2	4	1	6
Permitted Phases		8				
Actuated Green, G (s)	11.3	11.3	48.3	11.3	1.4	53.7
Effective Green, g (s)	11.3	11.3	48.3	11.3	1.4	53.7
Actuated g/C Ratio	0.15	0.15	0.64	0.15	0.02	0.72
Clearance Time (s)	5.0	5.0	5.0	5.0	4.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	267	243	2331	236	34	2543
v/s Ratio Prot	0.04		c0.41	c0.10	0.01	c0.19
v/s Ratio Perm		0.00				
v/c Ratio	0.23	0.01	0.64	0.65	0.29	0.26
Uniform Delay, d1	28.0	27.1	8.1	30.0	36.3	3.7
Progression Factor	1.00	1.00	0.51	1.72	1.00	1.00
Incremental Delay, d2	0.4	0.0	0.7	3.2	4.8	0.3
Delay (s)	28.5	27.1	4.9	54.8	41.1	4.0
Level of Service	C	C	A	D	D	A
Approach Delay (s)	28.3		12.0			4.5
Approach LOS	C		B			A

Intersection Summary			
HCM Average Control Delay	10.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	52.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

7: US-56 & Cedar Niles — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰↰	↑↑	↱		↰↑	↱↱	↰	↑↱	
Volume (vph)	50	1490	110	270	1380	70	90	20	510	40	10	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00		1.00	0.88	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85	1.00	0.88	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1805	3689	1615	3433	3654	1615		1825	2842	1752	1606	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.73	1.00	0.64	1.00	
Satd. Flow (perm)	1805	3689	1615	3433	3654	1615		1379	2842	1189	1606	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	56	1674	124	303	1551	79	101	22	573	45	11	45
RTOR Reduction (vph)	0	0	53	0	0	29	0	0	0	0	39	0
Lane Group Flow (vph)	56	1674	71	303	1551	50	0	123	573	45	17	0
Heavy Vehicles (%)	0%	3%	0%	2%	4%	0%	0%	0%	0%	3%	0%	5%
Turn Type	Prot		Perm	Prot		Perm	Perm		pt+ov	Perm		
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases			2			6	8			4		
Actuated Green, G (s)	6.4	51.2	51.2	11.8	56.6	56.6		11.4	27.2	11.4	11.4	
Effective Green, g (s)	6.4	51.2	51.2	11.8	56.6	56.6		11.4	23.2	11.4	11.4	
Actuated g/C Ratio	0.07	0.57	0.57	0.13	0.63	0.63		0.13	0.26	0.13	0.13	
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2		5.2	5.2	
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0		1.0		1.0	1.0	
Lane Grp Cap (vph)	128	2099	919	450	2298	1016		175	733	151	203	
v/s Ratio Prot	0.03	c0.45		0.09	0.42				c0.20		0.01	
v/s Ratio Perm			0.04			0.03		0.09		0.04		
v/c Ratio	0.44	0.80	0.08	0.67	0.67	0.05		0.70	0.78	0.30	0.08	
Uniform Delay, d1	40.1	15.3	8.7	37.3	10.8	6.4		37.7	31.0	35.7	34.7	
Progression Factor	1.00	1.00	1.00	0.83	0.64	0.94		1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.9	3.3	0.2	1.9	1.0	0.1		10.0	5.0	0.4	0.1	
Delay (s)	40.9	18.6	8.9	32.7	7.8	6.1		47.6	36.1	36.1	34.7	
Level of Service	D	B	A	C	A	A		D	D	D	C	
Approach Delay (s)		18.6			11.7			38.1			35.3	
Approach LOS		B			B			D			D	

Intersection Summary			
HCM Average Control Delay	19.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	16.8
Intersection Capacity Utilization	79.3%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

8: US-56 & I-35 SB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↱		↰	↑↑					↰		↱↱
Volume (vph)	0	1990	50	50	550	0	0	0	0	60	0	1160
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		1.00		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3513		1671	3689					1641		2760
Flt Permitted		1.00		0.95	1.00					0.95		1.00
Satd. Flow (perm)		3513		1671	3689					1641		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2095	53	53	579	0	0	0	0	63	0	1221
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	2146	0	53	579	0	0	0	0	63	0	1221
Heavy Vehicles (%)	0%	2%	18%	8%	3%	0%	0%	0%	0%	10%	0%	3%
Turn Type				Prot						Prot		custom
Protected Phases		2		1	6					7		5
Permitted Phases												4
Actuated Green, G (s)		65.2		4.2	28.4					5.6		41.0
Effective Green, g (s)		65.2		4.2	28.4					5.6		41.0
Actuated g/C Ratio		0.72		0.05	0.32					0.06		0.46
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2545		78	1164					102		1257
v/s Ratio Prot		c0.61		0.03	c0.16					c0.04		c0.44
v/s Ratio Perm												
v/c Ratio		0.84		0.68	0.50					0.62		0.97
Uniform Delay, d1		8.8		42.2	25.0					41.2		23.9
Progression Factor		0.64		0.97	0.84					1.00		1.00
Incremental Delay, d2		2.4		18.0	1.3					10.6		18.8
Delay (s)		8.0		59.0	22.4					51.8		42.7
Level of Service		A		E	C					D		D
Approach Delay (s)		8.0			25.4			0.0			43.2	
Approach LOS		A			C			A			D	

Intersection Summary			
HCM Average Control Delay	21.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	67.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

2015 Gardner IMF Operations + Induced Development - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
9: US-56 & I-35 NB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	400	0	0	430	140	170	0	110	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			0.97			0.95				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3689			1801			1629				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3689			1801			1629				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	455	0	0	489	159	193	0	125	0	0	0
RTOR Reduction (vph)	0	0	0	0	10	0	0	29	0	0	0	0
Lane Group Flow (vph)	0	455	0	0	638	0	0	289	0	0	0	0
Heavy Vehicles (%)	0%	3%	0%	0%	2%	2%	8%	0%	6%	0%	0%	0%
Turn Type							Perm					
Protected Phases		2			6			8				
Permitted Phases							8					
Actuated Green, G (s)		59.0			59.0			21.0				
Effective Green, g (s)		59.0			59.0			21.0				
Actuated g/C Ratio		0.66			0.66			0.23				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		2418			1181			380				
v/s Ratio Prot		0.12			c0.35							
v/s Ratio Perm								0.18				
v/c Ratio		0.19			0.54			0.76				
Uniform Delay, d1		6.1			8.3			32.2				
Progression Factor		0.31			1.00			1.00				
Incremental Delay, d2		0.1			1.8			8.7				
Delay (s)		2.0			10.0			40.8				
Level of Service		A			B			D				
Approach Delay (s)		2.0			10.0			40.8			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	14.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	105.5%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
10: Sante Fe & Moonlight — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	50	110	300	80	140	220
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.97		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3408		1787	3471
Flt Permitted	0.95	1.00	1.00		0.51	1.00
Satd. Flow (perm)	1770	1583	3408		963	3471
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	54	118	323	86	151	237
RTOR Reduction (vph)	0	107	18	0	0	0
Lane Group Flow (vph)	54	11	391	0	151	237
Heavy Vehicles (%)	2%	2%	3%	1%	1%	4%
Turn Type		Perm			Perm	
Protected Phases	6		8			4
Permitted Phases		6			4	
Actuated Green, G (s)	6.8	6.8	58.2		58.2	58.2
Effective Green, g (s)	6.8	6.8	58.2		58.2	58.2
Actuated g/C Ratio	0.09	0.09	0.78		0.78	0.78
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	160	144	2645		747	2693
v/s Ratio Prot	c0.03		0.11			0.07
v/s Ratio Perm		0.01			c0.16	
v/c Ratio	0.34	0.07	0.15		0.20	0.09
Uniform Delay, d1	32.0	31.2	2.1		2.2	2.0
Progression Factor	1.00	1.00	1.00		0.98	0.85
Incremental Delay, d2	1.3	0.2	0.1		0.6	0.1
Delay (s)	33.2	31.4	2.2		2.8	1.8
Level of Service	C	C	A		A	A
Approach Delay (s)	32.0		2.2			2.2
Approach LOS	C		A			A

Intersection Summary			
HCM Average Control Delay	7.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.22		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	36.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
11: Waverly Road & US 56 — AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	30	50	10	50	10	70	290	10	190	90	10
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	38	63	13	63	13	89	367	13	241	114	13
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1196	1158	373	1234	1158	120	127			380		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1196	1158	373	1234	1158	120	127			380		
tC, single (s)	7.1	6.5	6.5	7.1	6.5	6.3	4.1			4.2		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.6	3.5	4.0	3.4	2.2			2.3		
p0 queue free %	93	74	90	86	57	99	94			79		
cM capacity (veh/h)	87	145	611	90	146	910	1453			1152		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	108	89	468	367
Volume Left	6	13	89	241
Volume Right	63	13	13	13
cSH	246	150	1453	1152
Volume to Capacity	0.44	0.59	0.06	0.21
Queue Length 95th (ft)	52	77	5	20
Control Delay (s)	30.6	58.6	1.9	6.6
Lane LOS	D	F	A	A
Approach Delay (s)	30.6	58.6	1.9	6.6
Approach LOS	D	F		

Intersection Summary			
Average Delay	11.4		
Intersection Capacity Utilization	52.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
12: 183rd Street & Four Corners Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	10	5	5	10	10	10	10	5	5	10	5
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	11	5	5	11	11	11	11	5	5	11	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	22	27	27	22
Volume Left (vph)	5	5	11	5
Volume Right (vph)	5	11	5	5
Hadj (s)	-0.10	-0.20	-0.04	-0.10
Departure Headway (s)	3.9	3.8	4.0	3.9
Degree Utilization, x	0.02	0.03	0.03	0.02
Capacity (veh/h)	898	924	880	900
Control Delay (s)	7.0	6.9	7.1	7.0
Approach Delay (s)	7.0	6.9	7.1	7.0
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.0		
HCM Level of Service	A		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

13: 183rd Street & US 56 — AM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	5	0	0	360	100	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	0	0	456	127	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	585	130	133			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	585	130	133			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	99	100	100			
cM capacity (veh/h)	476	925	1464			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	6	456	133
Volume Left	6	0	0
Volume Right	0	0	6
cSH	476	1464	1700
Volume to Capacity	0.01	0.00	0.08
Queue Length 95th (ft)	1	0	0
Control Delay (s)	12.7	0.0	0.0
Lane LOS	B		
Approach Delay (s)	12.7	0.0	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	28.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

14: 183rd Street & Waverly Road — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	20	90	50	20	10	80
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	22	98	54	22	11	87
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	174	65			76	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	174	65			76	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	97	90			99	
cM capacity (veh/h)	815	1004			1536	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	120	76	98
Volume Left	22	0	11
Volume Right	98	22	0
cSH	964	1700	1536
Volume to Capacity	0.12	0.04	0.01
Queue Length 95th (ft)	11	0	1
Control Delay (s)	9.3	0.0	0.9
Lane LOS	A		A
Approach Delay (s)	9.3	0.0	0.9
Approach LOS	A		

Intersection Summary			
Average Delay	4.1		
Intersection Capacity Utilization	24.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

15: 183rd Street & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	20	110	130	30	110	90	480	50	40	400	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	2.5	2.5		2.5	2.5		2.5	2.5		2.5	2.5	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.87		1.00	0.88		1.00	0.99		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1805	1658		1805	1676		1805	3435		1805	3485	
Flt Permitted	0.63	1.00		0.35	1.00		0.45	1.00		0.39	1.00	
Satd. Flow (perm)	1203	1658		662	1676		853	3435		734	3485	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	56	22	124	146	34	124	101	539	56	45	449	22
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	56	146	0	146	158	0	101	595	0	45	471	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	4%	0%	0%	3%	0%
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	22.8	15.9		31.2	21.8		78.8	71.9		73.2	68.8	
Effective Green, g (s)	22.8	15.9		31.2	21.8		78.8	71.9		73.2	68.8	
Actuated g/C Ratio	0.20	0.14		0.27	0.19		0.69	0.63		0.64	0.60	
Clearance Time (s)	2.5	2.5		2.5	2.5		2.5	2.5		2.5	2.5	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	275	229		307	318		647	2148		508	2085	
v/s Ratio Prot	0.01	c0.09		c0.05	0.09		c0.01	c0.17		0.00	0.14	
v/s Ratio Perm	0.03			0.08			0.10			0.05		
v/c Ratio	0.20	0.64		0.48	0.50		0.16	0.28		0.09	0.23	
Uniform Delay, d1	38.1	46.8		33.6	41.7		8.2	9.8		10.8	10.7	
Progression Factor	1.00	1.00		1.00	1.00		0.98	0.94		1.00	1.00	
Incremental Delay, d2	0.4	5.7		1.2	1.2		0.1	0.3		0.1	0.1	
Delay (s)	38.6	52.6		34.8	42.9		8.2	9.5		10.8	10.8	
Level of Service	D	D		C	D		A	A		B	B	
Approach Delay (s)		48.7			39.0			9.3			10.8	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM Average Control Delay	19.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.35		
Actuated Cycle Length (s)	115.0	Sum of lost time (s)	7.5
Intersection Capacity Utilization	46.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

16: Four Corners Road & US 56 — AM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	0	10	10	370	110	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	0	13	13	487	145	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	658	145	145			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	658	145	145			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	99	99			
cM capacity (veh/h)	428	908	1450			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	13	500	145
Volume Left	0	13	0
Volume Right	13	0	0
cSH	908	1450	1700
Volume to Capacity	0.01	0.01	0.09
Queue Length 95th (ft)	1	1	0
Control Delay (s)	9.0	0.3	0.0
Lane LOS	A	A	
Approach Delay (s)	9.0	0.3	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	36.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
17: 191st Street & US 56 — AM Peak Hour

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	10	5	0	380	110	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	13	6	0	494	143	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	640	146	149			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	640	146	149			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	99	100			
cM capacity (veh/h)	443	906	1444			

Direction, Lane #	SE 1	NE 1	SW 1
Volume Total	19	494	149
Volume Left	13	0	0
Volume Right	6	0	6
cSH	534	1444	1700
Volume to Capacity	0.04	0.00	0.09
Queue Length 95th (ft)	3	0	0
Control Delay (s)	12.0	0.0	0.0
Lane LOS	B		
Approach Delay (s)	12.0	0.0	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	30.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
19: 191st Street & Waverly Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	20	140	5	5	220	50	5	5	5	40	5	60
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	22	152	5	5	239	54	5	5	5	43	5	65
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	293			158			543	503	155	484	478	266
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	293			158			543	503	155	484	478	266
tC, single (s)	4.6			4.1			7.1	6.5	6.2	7.2	6.5	6.4
tC, 2 stage (s)												
tF (s)	2.7			2.2			3.5	4.0	3.3	3.6	4.0	3.4
p0 queue free %	98			100			99	99	99	91	99	91
cM capacity (veh/h)	1038			1434			402	462	896	460	477	742

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	179	299	16	114
Volume Left	22	5	5	43
Volume Right	5	54	5	65
cSH	1038	1434	520	589
Volume to Capacity	0.02	0.00	0.03	0.19
Queue Length 95th (ft)	2	0	2	18
Control Delay (s)	1.2	0.2	12.1	12.6
Lane LOS	A	A	B	B
Approach Delay (s)	1.2	0.2	12.1	12.6
Approach LOS			B	B

Intersection Summary			
Average Delay	3.1		
Intersection Capacity Utilization	34.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
20: W 188th Street & Gardner Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	5	180	10	5	10	240	330	5	5	570	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00			0.95			0.95	1.00
Frt	1.00	1.00	0.85		0.94			1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00		0.98			0.98			1.00	1.00
Satd. Flow (prot)	1805	1900	1049		1760			3071			3538	1538
Flt Permitted	0.74	1.00	1.00		0.88			0.61			0.95	1.00
Satd. Flow (perm)	1405	1900	1049		1589			1904			3367	1538
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	11	5	189	11	5	11	253	347	5	5	600	21
RTOR Reduction (vph)	0	0	172	0	10	0	0	0	0	0	0	4
Lane Group Flow (vph)	11	5	17	0	17	0	0	605	0	0	605	17
Heavy Vehicles (%)	0%	0%	54%	0%	0%	0%	29%	5%	0%	0%	2%	5%
Turn Type	Perm		Perm	Perm			Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	10.1	10.1	10.1		10.1			94.9			94.9	94.9
Effective Green, g (s)	10.1	10.1	10.1		10.1			94.9			94.9	94.9
Actuated g/C Ratio	0.09	0.09	0.09		0.09			0.83			0.83	0.83
Clearance Time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	123	167	92		140			1571			2779	1269
v/s Ratio Prot		0.00										
v/s Ratio Perm	0.01		c0.02		0.01			c0.32			0.18	0.01
v/c Ratio	0.09	0.03	0.18		0.12			0.38			0.22	0.01
Uniform Delay, d1	48.2	48.0	48.6		48.4			2.6			2.1	1.8
Progression Factor	1.00	1.00	1.00		1.00			0.71			0.37	0.46
Incremental Delay, d2	0.3	0.1	0.9		0.4			0.7			0.2	0.0
Delay (s)	48.5	48.0	49.6		48.7			2.5			1.0	0.8
Level of Service	D	D	D		D			A			A	A
Approach Delay (s)		49.5			48.7			2.5			1.0	
Approach LOS		D			D			A			A	

Intersection Summary			
HCM Average Control Delay	9.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.37		
Actuated Cycle Length (s)	115.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	52.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
21: I-35 SB Ramps & Gardner Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	40	0	290	10	290	0	0	700	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0		5.0		5.0			5.0	5.0
Lane Util. Factor				1.00		1.00		1.00			1.00	1.00
Frt				1.00		0.85		1.00			1.00	0.85
Flt Protected				0.95		1.00		1.00			1.00	1.00
Satd. Flow (prot)				1671		1282		1826			1667	1442
Flt Permitted				0.95		1.00		0.97			1.00	1.00
Satd. Flow (perm)				1671		1282		1783			1667	1442
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	43	0	309	11	309	0	0	745	64
RTOR Reduction (vph)	0	0	0	0	0	280	0	0	0	0	0	12
Lane Group Flow (vph)	0	0	0	43	0	29	0	320	0	0	745	52
Heavy Vehicles (%)	0%	0%	0%	8%	0%	26%	0%	4%	0%	0%	14%	12%
Turn Type				Prot		custom	Perm					Perm
Protected Phases				3				2			6	
Permitted Phases						3	2					6
Actuated Green, G (s)				10.8		10.8		94.2			94.2	94.2
Effective Green, g (s)				10.8		10.8		94.2			94.2	94.2
Actuated g/C Ratio				0.09		0.09		0.82			0.82	0.82
Clearance Time (s)				5.0		5.0		5.0			5.0	5.0
Vehicle Extension (s)				3.0		3.0		3.0			3.0	3.0
Lane Grp Cap (vph)				157		120		1461			1365	1181
v/s Ratio Prot				c0.03							c0.45	
v/s Ratio Perm						0.02		0.18				0.04
v/c Ratio				0.27		0.24		0.22			0.55	0.04
Uniform Delay, d1				48.5		48.3		2.3			3.4	2.0
Progression Factor				1.00		1.00		1.52			0.72	0.17
Incremental Delay, d2				0.9		1.0		0.3			1.5	0.1
Delay (s)				49.4		49.4		3.7			4.0	0.4
Level of Service				D		D		A			A	A
Approach Delay (s)		0.0			49.4			3.7			3.7	
Approach LOS		A			D			A			A	

Intersection Summary			
HCM Average Control Delay	14.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	115.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	47.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

22: I-35 NB Ramps & Gardner Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	120	0	20	0	0	0	0	180	210	610	140	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.98						0.93			1.00	
Flt Protected		0.96						1.00			0.96	
Satd. Flow (prot)		1716						1721			1599	
Flt Permitted		0.96						1.00			0.51	
Satd. Flow (perm)		1716						1721			857	
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	132	0	22	0	0	0	0	198	231	670	154	0
RTOR Reduction (vph)	0	6	0	0	0	0	0	36	0	0	0	0
Lane Group Flow (vph)	0	148	0	0	0	0	0	393	0	0	824	0
Heavy Vehicles (%)	4%	0%	5%	0%	0%	0%	0%	4%	1%	17%	2%	0%
Turn Type	Perm									Perm		
Protected Phases		4						2			6	
Permitted Phases	4									6		
Actuated Green, G (s)		8.0						97.0			97.0	
Effective Green, g (s)		8.0						97.0			97.0	
Actuated g/C Ratio		0.07						0.84			0.84	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		119						1452			723	
v/s Ratio Prot								0.23				
v/s Ratio Perm		0.09									c0.96	
v/c Ratio		1.25						0.27			1.14	
Uniform Delay, d1		53.5						1.8			9.0	
Progression Factor		1.00						1.00			1.30	
Incremental Delay, d2		163.2						0.5			77.4	
Delay (s)		216.7						2.3			89.0	
Level of Service		F						A			F	
Approach Delay (s)		216.7			0.0			2.3			89.0	
Approach LOS		F			A			A			F	

Intersection Summary			
HCM Average Control Delay	76.6	HCM Level of Service	E
HCM Volume to Capacity ratio	1.15		
Actuated Cycle Length (s)	115.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	83.8%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

23: E 191st Street & Gardner Rd

AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	10	380	0	5	150
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	11	409	0	5	161
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						220
pX, platoon unblocked						
vC, conflicting volume	581	409			409	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	581	409			409	
tC, single (s)	6.4	6.2			4.3	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.4	
p0 queue free %	100	98			99	
cM capacity (veh/h)	477	647			1060	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	11	409	167
Volume Left	0	0	5
Volume Right	11	0	0
cSH	647	1700	1060
Volume to Capacity	0.02	0.24	0.01
Queue Length 95th (ft)	1	0	0
Control Delay (s)	10.7	0.0	0.3
Lane LOS	B		A
Approach Delay (s)	10.7	0.0	0.3
Approach LOS	B		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	30.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

24: Sunflower Road & US 56

AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	10	40	0	0	10	390	70	5	110	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	6	13	51	0	0	13	494	89	6	139	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	715	759	139	731	715	538	139			582		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	715	759	139	731	715	538	139			582		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	84	100	100	99			99		
cM capacity (veh/h)	344	333	914	317	353	547	1457			1002		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	25	51	595	146
Volume Left	6	51	13	6
Volume Right	13	0	89	0
cSH	494	317	1457	1002
Volume to Capacity	0.05	0.16	0.01	0.01
Queue Length 95th (ft)	4	14	1	0
Control Delay (s)	12.7	18.5	0.3	0.4
Lane LOS	B	C	A	A
Approach Delay (s)	12.7	18.5	0.3	0.4
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	42.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

25: US 56 & 4th Street

AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	410	60	20	130	20	50
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	526	77	26	167	26	64
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			603		782	564
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			603		782	564
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		93	88
cM capacity (veh/h)			960		349	525

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	603	192	90
Volume Left	0	26	26
Volume Right	77	0	64
cSH	1700	960	459
Volume to Capacity	0.35	0.03	0.20
Queue Length 95th (ft)	0	2	18
Control Delay (s)	0.0	1.4	14.7
Lane LOS		A	B
Approach Delay (s)	0.0	1.4	14.7
Approach LOS			B

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	36.1%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Gardner IMF Operations + Induced Development - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

26: 199th Street & Four Corners Road

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	70	30	20	10	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	12	83	36	24	12	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	60				155	48
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	60				155	48
tC, single (s)	4.3				6.6	6.6
tC, 2 stage (s)						
tF (s)	2.4				3.7	3.7
p0 queue free %	99				98	99
cM capacity (veh/h)	1437				790	923

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	95	60	18
Volume Left	12	0	12
Volume Right	0	24	6
cSH	1437	1700	830
Volume to Capacity	0.01	0.04	0.02
Queue Length 95th (ft)	1	0	2
Control Delay (s)	1.0	0.0	9.4
Lane LOS	A		A
Approach Delay (s)	1.0	0.0	9.4
Approach LOS			A

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	20.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

27: 199th Street & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	70	30	10	5	30	70	10	270	10	40	70	40
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	79	34	11	6	34	79	11	303	11	45	79	45

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	124	118	326	169
Volume Left (vph)	79	6	11	45
Volume Right (vph)	11	79	11	45
Hadj (s)	0.13	-0.34	0.03	-0.07
Departure Headway (s)	5.4	5.0	4.8	4.9
Degree Utilization, x	0.19	0.16	0.44	0.23
Capacity (veh/h)	597	643	716	680
Control Delay (s)	9.7	9.0	11.5	9.4
Approach Delay (s)	9.7	9.0	11.5	9.4
Approach LOS	A	A	B	A

Intersection Summary			
Delay	10.3		
HCM Level of Service	B		
Intersection Capacity Utilization	45.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

30: US-56 & I-35 NB Loop

AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	410	1650	0	600	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	461	1854	0	674	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked						
vC, conflicting volume			2315		798	230
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			2315		798	230
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			219		328	778

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	230	230	1854	337	337
Volume Left	0	0	0	0	0
Volume Right	0	0	1854	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.14	0.14	1.09	0.20	0.20
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	105.5%	ICU Level of Service	G
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

80: 191st Street & Driveway A

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	10	5	70	95	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	11	5	76	103	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	82				65	43
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	82				65	43
tC, single (s)	5.1				7.4	7.2
tC, 2 stage (s)						
tF (s)	3.1				4.4	4.2
p0 queue free %	99				86	99
cM capacity (veh/h)	1071				741	806

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	16	82	103	5
Volume Left	5	0	103	0
Volume Right	0	76	0	5
cSH	1071	1700	741	806
Volume to Capacity	0.01	0.05	0.14	0.01
Queue Length 95th (ft)	0	0	12	1
Control Delay (s)	2.8	0.0	10.6	9.5
Lane LOS	A		B	A
Approach Delay (s)	2.8	0.0	10.6	
Approach LOS			B	

Intersection Summary			
Average Delay	5.8		
Intersection Capacity Utilization	16.9%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Gardner IMF Operations + Induced Development - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
81: 191st Street & Driveway B — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	120	90	180	30	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	130	98	196	33	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	293				348	196
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	293				348	196
tC, single (s)	4.5				6.8	7.0
tC, 2 stage (s)						
tF (s)	2.6				3.8	4.0
p0 queue free %	99				94	99
cM capacity (veh/h)	1080				578	681

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	141	293	33	5
Volume Left	11	0	33	0
Volume Right	0	196	0	5
cSH	1080	1700	578	681
Volume to Capacity	0.01	0.17	0.06	0.01
Queue Length 95th (ft)	1	0	4	1
Control Delay (s)	0.7	0.0	11.6	10.3
Lane LOS	A		B	B
Approach Delay (s)	0.7	0.0	11.4	
Approach LOS			B	

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	25.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
82: Driveway C & Waverly Road — AM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	30	30	30	30	70	30
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	33	33	33	33	76	33
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	190	92	109			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	190	92	109			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	96	97	98			
cM capacity (veh/h)	786	970	1494			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	33	33	65	109
Volume Left	33	0	33	0
Volume Right	0	33	0	33
cSH	786	970	1494	1700
Volume to Capacity	0.04	0.03	0.02	0.06
Queue Length 95th (ft)	3	3	2	0
Control Delay (s)	9.8	8.8	3.8	0.0
Lane LOS	A	A	A	
Approach Delay (s)	9.3		3.8	0.0
Approach LOS	A			

Intersection Summary			
Average Delay	3.6		
Intersection Capacity Utilization	19.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
83: Driveway D & Waverly Road — AM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	30	20	90	40	70	170
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	33	22	98	43	76	185
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	408	168	261			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	408	168	261			
tC, single (s)	6.8	6.7	4.2			
tC, 2 stage (s)						
tF (s)	3.9	3.8	2.3			
p0 queue free %	93	97	92			
cM capacity (veh/h)	492	765	1258			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	33	22	141	261
Volume Left	33	0	98	0
Volume Right	0	22	0	185
cSH	492	765	1258	1700
Volume to Capacity	0.07	0.03	0.08	0.15
Queue Length 95th (ft)	5	2	6	0
Control Delay (s)	12.8	9.8	5.8	0.0
Lane LOS	B	A	A	
Approach Delay (s)	11.6		5.8	0.0
Approach LOS	B			

Intersection Summary			
Average Delay	3.2		
Intersection Capacity Utilization	34.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
84: 191st Street & Driveway E — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	105	70	20	20	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	114	76	22	22	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	98				212	87
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	98				212	87
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				97	99
cM capacity (veh/h)	1508				778	977

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	120	98	27
Volume Left	5	0	22
Volume Right	0	22	5
cSH	1508	1700	811
Volume to Capacity	0.00	0.06	0.03
Queue Length 95th (ft)	0	0	3
Control Delay (s)	0.4	0.0	9.6
Lane LOS	A		A
Approach Delay (s)	0.4	0.0	9.6
Approach LOS			A

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	19.6%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Gardner IMF Operations + Induced Development - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

1: 175th Street & Waverly Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✥			✥			✥			✥	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	100	10	5	320	90	20	40	5	40	40	20
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	24	120	12	6	386	108	24	48	6	48	48	24

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	157	500	78	120
Volume Left (vph)	24	6	24	48
Volume Right (vph)	12	108	6	24
Hadj (s)	0.06	-0.07	0.04	-0.02
Departure Headway (s)	5.2	4.6	5.8	5.6
Degree Utilization, x	0.23	0.64	0.13	0.19
Capacity (veh/h)	643	754	538	566
Control Delay (s)	9.7	15.7	9.6	9.9
Approach Delay (s)	9.7	15.7	9.6	9.9
Approach LOS	A	C	A	A

Intersection Summary			
Delay	13.2		
HCM Level of Service	B		
Intersection Capacity Utilization	37.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

2: US 56 & Gardner Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱			↰↑↱		↰	↑↱		↰	↑↱	
Volume (vph)	50	420	60	250	820	250	70	170	160	160	170	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.98			0.97		1.00	0.93		1.00	0.96	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3284			3358		1787	1694		1736	1752	
Flt Permitted		0.64			0.69		0.45	1.00		0.30	1.00	
Satd. Flow (perm)		2121			2335		846	1694		541	1752	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	57	483	69	287	943	287	80	195	184	184	195	80
RTOR Reduction (vph)	0	10	0	0	20	0	0	34	0	0	15	0
Lane Group Flow (vph)	0	599	0	0	1497	0	80	345	0	184	260	0
Heavy Vehicles (%)	2%	9%	2%	1%	5%	1%	1%	4%	4%	4%	4%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		59.1			59.1		29.2	29.2		29.2	29.2	
Effective Green, g (s)		59.1			59.1		29.2	29.2		29.2	29.2	
Actuated g/C Ratio		0.59			0.59		0.29	0.29		0.29	0.29	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1254			1380		247	495		158	512	
v/s Ratio Prot								0.20			0.15	
v/s Ratio Perm		0.28			c0.64		0.09			c0.34		
v/c Ratio		0.48			1.08		0.32	0.70		1.16	0.51	
Uniform Delay, d1		11.7			20.5		27.7	31.5		35.4	29.4	
Progression Factor		1.00			0.47		1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.3			49.2		0.8	4.3		122.7	0.8	
Delay (s)		13.0			58.8		28.4	35.7		158.1	30.2	
Level of Service		B			E		C	D		F	C	
Approach Delay (s)		13.0			58.8			34.5			81.5	
Approach LOS		B			E			C			F	

Intersection Summary			
HCM Average Control Delay	49.4	HCM Level of Service	D
HCM Volume to Capacity ratio	1.11		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	11.7
Intersection Capacity Utilization	100.0%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

3: US 56 & Elm

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱			↰↑↱			✥			✥	
Volume (vph)	10	760	20	40	1290	40	20	10	50	70	10	30
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			1.00			0.92			0.96	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3577			3671			1765			1856	
Flt Permitted		0.93			0.90			0.92			0.72	
Satd. Flow (perm)		3324			3304			1638			1373	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	11	817	22	43	1387	43	22	11	54	75	11	32
RTOR Reduction (vph)	0	1	0	0	1	0	0	47	0	0	16	0
Lane Group Flow (vph)	0	849	0	0	1472	0	0	40	0	0	102	0
Heavy Vehicles (%)	0%	6%	0%	3%	3%	0%	5%	0%	2%	1%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		78.3			78.3			12.7			12.7	
Effective Green, g (s)		78.3			78.3			12.7			12.7	
Actuated g/C Ratio		0.78			0.78			0.13			0.13	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2603			2587			208			174	
v/s Ratio Prot												
v/s Ratio Perm		0.26			c0.45			0.02			c0.07	
v/c Ratio		0.33			0.57			0.19			0.59	
Uniform Delay, d1		3.2			4.2			39.1			41.2	
Progression Factor		0.60			0.22			1.00			1.00	
Incremental Delay, d2		0.2			0.2			0.5			5.0	
Delay (s)		2.1			1.2			39.5			46.2	
Level of Service		A			A			D			D	
Approach Delay (s)		2.1			1.2			39.5			46.2	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	4.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	82.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

4: US 56 & Mulberry

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱			↰↑↱			✥			✥	
Volume (vph)	10	870	10	30	1380	40	10	5	20	40	10	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			1.00			0.92			0.96	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3402			3492			1678			1776	
Flt Permitted		0.93			0.91			0.92			0.87	
Satd. Flow (perm)		3164			3197			1567			1583	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	11	935	11	32	1484	43	11	5	22	43	11	22
RTOR Reduction (vph)	0	1	0	0	2	0	0	20	0	0	16	0
Lane Group Flow (vph)	0	956	0	0	1557	0	0	18	0	0	60	0
Heavy Vehicles (%)	0%	6%	0%	0%	3%	0%	0%	0%	5%	0%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		83.0			83.0			8.0			8.0	
Effective Green, g (s)		83.0			83.0			8.0			8.0	
Actuated g/C Ratio		0.83			0.83			0.08			0.08	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2626			2654			125			127	
v/s Ratio Prot												
v/s Ratio Perm		0.30			c0.49			0.01			c0.04	
v/c Ratio		0.36			0.59			0.14			0.48	
Uniform Delay, d1		2.1			2.8			42.8			44.0	
Progression Factor		0.98			0.81			1.00			1.00	
Incremental Delay, d2		0.4			0.2			0.5			2.8	
Delay (s)		2.4			2.5			43.3			46.8	
Level of Service		A			A			D			D	
Approach Delay (s)		2.4			2.5			43.3			46.8	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	4.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	75.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
5: US 56 & Moonlight Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↑	↱	↰	↑↑	↱	↰↰	↑↑	↱
Volume (vph)	140	560	250	190	1160	600	150	190	60	280	240	110
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1736	3551	1583	1770	3505	1583	1770	3539	1583	3433	3539	1553
Flt Permitted	0.11	1.00	1.00	0.37	1.00	1.00	0.59	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	206	3551	1583	687	3505	1583	1097	3539	1583	3433	3539	1553
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	154	615	275	209	1275	659	165	209	66	308	264	121
RTOR Reduction (vph)	0	0	143	0	0	250	0	0	60	0	0	108
Lane Group Flow (vph)	154	615	132	209	1275	409	165	209	6	308	264	13
Heavy Vehicles (%)	4%	7%	2%	2%	3%	2%	2%	2%	2%	2%	2%	4%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	Prot		Perm
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6	8		8			4
Actuated Green, G (s)	55.9	47.9	47.9	57.7	48.8	48.8	17.5	8.4	8.4	11.8	11.1	11.1
Effective Green, g (s)	55.9	47.9	47.9	57.7	48.8	48.8	17.5	8.4	8.4	11.8	11.1	11.1
Actuated g/C Ratio	0.56	0.48	0.48	0.58	0.49	0.49	0.18	0.08	0.08	0.12	0.11	0.11
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	238	1701	758	493	1710	773	253	297	133	405	393	172
v/s Ratio Prot	c0.05	0.17		0.04	c0.36		0.06	0.06		c0.09	c0.07	
v/s Ratio Perm	0.31		0.08	0.21		0.26	0.05		0.00			0.01
v/c Ratio	0.65	0.36	0.17	0.42	0.75	0.53	0.65	0.70	0.04	0.76	0.67	0.08
Uniform Delay, d1	15.0	16.4	14.8	10.4	20.6	17.7	37.5	44.6	42.1	42.7	42.7	39.9
Progression Factor	1.35	0.76	0.83	0.67	0.82	0.80	0.93	0.94	0.79	1.00	1.00	1.00
Incremental Delay, d2	4.3	0.6	0.5	0.2	2.4	2.0	4.5	6.0	0.0	7.4	3.5	0.1
Delay (s)	24.6	13.0	12.7	7.2	19.2	16.1	39.3	48.0	33.4	50.1	46.2	39.9
Level of Service	C	B	B	A	B	B	D	D	C	D	D	D
Approach Delay (s)		14.6			17.1			42.5			46.9	
Approach LOS		B			B			D			D	

Intersection Summary			
HCM Average Control Delay	23.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	16.5
Intersection Capacity Utilization	74.0%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
6: Old US 56 & US 56 — PM Peak Hour

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations	↰	↱	↑↑	↱	↰	↑↑
Volume (vph)	130	20	780	120	10	1830
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	4.0	6.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1736	1538	3619	1568	1805	3689
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1736	1538	3619	1568	1805	3689
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	134	21	804	124	10	1887
RTOR Reduction (vph)	0	18	0	66	0	0
Lane Group Flow (vph)	134	3	804	58	10	1887
Heavy Vehicles (%)	4%	5%	5%	3%	0%	3%
Turn Type		Perm		custom	Prot	
Protected Phases	8		2	4	1	6
Permitted Phases		8				
Actuated Green, G (s)	12.8	12.8	71.7	12.8	1.5	76.2
Effective Green, g (s)	12.8	12.8	71.7	12.8	1.5	76.2
Actuated g/C Ratio	0.13	0.13	0.72	0.13	0.02	0.76
Clearance Time (s)	5.0	5.0	5.0	5.0	4.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	222	197	2595	201	27	2811
v/s Ratio Prot	c0.08		0.22	0.04	0.01	c0.51
v/s Ratio Perm		0.00				
v/c Ratio	0.60	0.01	0.31	0.29	0.37	0.67
Uniform Delay, d1	41.2	38.1	5.1	39.5	48.8	5.8
Progression Factor	1.00	1.00	1.28	1.17	1.00	1.00
Incremental Delay, d2	4.6	0.0	0.3	0.7	8.4	1.3
Delay (s)	45.8	38.1	6.9	46.8	57.2	7.1
Level of Service	D	D	A	D	E	A
Approach Delay (s)	44.7		12.2			7.4
Approach LOS	D		B			A

Intersection Summary			
HCM Average Control Delay	10.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	11.0
Intersection Capacity Utilization	64.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
7: US-56 & Cedar Niles — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰↰	↑↑	↱		↰↑	↱↱	↰	↑↱	
Volume (vph)	40	1410	180	520	1430	40	140	20	400	40	10	30
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00		1.00	0.88	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85	1.00	0.89	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1805	3689	1599	3502	3654	1615		1820	2842	1805	1685	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.72	1.00	0.43	1.00	
Satd. Flow (perm)	1805	3689	1599	3502	3654	1615		1368	2842	809	1685	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	45	1584	202	584	1607	45	157	22	449	45	11	34
RTOR Reduction (vph)	0	0	94	0	0	15	0	0	0	0	29	0
Lane Group Flow (vph)	45	1584	108	584	1607	30	0	179	449	45	16	0
Heavy Vehicles (%)	0%	3%	1%	0%	4%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Prot		Perm	Prot		Perm	Perm		pt+ov	Perm		
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases			2			6	8			4		
Actuated Green, G (s)	6.4	63.9	63.9	22.6	80.1	80.1		17.9	44.5	17.9	17.9	
Effective Green, g (s)	6.4	63.9	63.9	22.6	80.1	80.1		17.9	40.5	17.9	17.9	
Actuated g/C Ratio	0.05	0.53	0.53	0.19	0.67	0.67		0.15	0.34	0.15	0.15	
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2		5.2	5.2	
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0		1.0		1.0	1.0	
Lane Grp Cap (vph)	96	1964	851	660	2439	1078		204	959	121	251	
v/s Ratio Prot	0.02	c0.43		c0.17	0.44				0.16		0.01	
v/s Ratio Perm			0.07			0.02		c0.13		0.06		
v/c Ratio	0.47	0.81	0.13	0.88	0.66	0.03		0.88	0.47	0.37	0.06	
Uniform Delay, d1	55.1	23.0	14.1	47.4	11.8	6.8		50.0	31.3	46.0	43.9	
Progression Factor	1.00	1.00	1.00	0.80	0.47	0.19		1.00	1.00	1.00	1.00	
Incremental Delay, d2	1.3	3.7	0.3	7.0	0.7	0.0		31.0	0.1	0.7	0.0	
Delay (s)	56.5	26.7	14.4	45.1	6.2	1.3		81.0	31.4	46.7	43.9	
Level of Service	E	C	B	D	A	A		F	C	D	D	
Approach Delay (s)		26.0			16.3			45.5			45.3	
Approach LOS		C			B			D			D	

Intersection Summary			
HCM Average Control Delay	24.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.6
Intersection Capacity Utilization	80.3%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
8: US-56 & I-35 SB Ramps — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↱		↰	↑↑					↰		↱↱
Volume (vph)	0	1610	240	130	540	0	0	0	0	140	0	1450
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		0.98		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3437		1687	3725					1787		2760
Flt Permitted		1.00		0.95	1.00					0.95		1.00
Satd. Flow (perm)		3437		1687	3725					1787		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1695	253	137	568	0	0	0	0	147	0	1526
RTOR Reduction (vph)	0	10	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	1938	0	137	568	0	0	0	0	147	0	1526
Heavy Vehicles (%)	0%	3%	3%	7%	2%	0%	0%	0%	0%	1%	0%	3%
Turn Type				Prot						Prot		custom
Protected Phases		2		1	6					7		5
Permitted Phases												4
Actuated Green, G (s)		77.3		14.7	27.1					13.0		64.9
Effective Green, g (s)		77.3		14.7	27.1					13.0		64.9
Actuated g/C Ratio		0.64		0.12	0.23					0.11		0.54
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2214		207	841					194		1493
v/s Ratio Prot		c0.56		0.08	c0.15					c0.08		c0.55
v/s Ratio Perm												
v/c Ratio		0.88		0.66	0.68					0.76		1.02
Uniform Delay, d1		17.4		50.3	42.4					52.0		27.6
Progression Factor		0.59		0.96	0.96					1.00		1.00
Incremental Delay, d2		3.7		7.0	3.9					15.5		29.0
Delay (s)		14.0		55.3	44.5					67.5		56.6
Level of Service		B		E	D					E		E
Approach Delay (s)		14.0			46.6			0.0			57.5	
Approach LOS		B			D			A			E	

Intersection Summary			
HCM Average Control Delay	36.2	HCM Level of Service	D
HCM Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	78.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

2015 Gardner IMF Operations + Induced Development - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
9: US-56 & I-35 NB Ramps — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	540	0	0	580	20	90	0	60	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			1.00			0.95				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3762			1832			1595				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3762			1832			1595				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	614	0	0	659	23	102	0	68	0	0	0
RTOR Reduction (vph)	0	0	0	0	1	0	0	22	0	0	0	0
Lane Group Flow (vph)	0	614	0	0	681	0	0	148	0	0	0	0
Heavy Vehicles (%)	0%	1%	0%	0%	3%	10%	7%	0%	13%	0%	0%	0%
Turn Type							Perm					
Protected Phases		2			6			8				
Permitted Phases							8					
Actuated Green, G (s)		93.7			93.7			16.3				
Effective Green, g (s)		93.7			93.7			16.3				
Actuated g/C Ratio		0.78			0.78			0.14				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		2937			1430			217				
v/s Ratio Prot		0.16			c0.37							
v/s Ratio Perm								0.09				
v/c Ratio		0.21			0.48			0.68				
Uniform Delay, d1		3.4			4.6			49.4				
Progression Factor		1.22			1.00			1.00				
Incremental Delay, d2		0.1			1.1			8.2				
Delay (s)		4.3			5.7			57.6				
Level of Service		A			A			E				
Approach Delay (s)		4.3			5.7			57.6			0.0	
Approach LOS		A			A			E			A	

Intersection Summary			
HCM Average Control Delay	11.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	77.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
10: Sante Fe & Moonlight — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	110	130	270	70	160	530
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.97		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3457		1770	3539
Flt Permitted	0.95	1.00	1.00		0.53	1.00
Satd. Flow (perm)	1770	1583	3457		995	3539
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	118	140	290	75	172	570
RTOR Reduction (vph)	0	123	13	0	0	0
Lane Group Flow (vph)	118	17	352	0	172	570
Heavy Vehicles (%)	2%	2%	1%	2%	2%	2%
Turn Type		Perm			Perm	
Protected Phases	6		8			4
Permitted Phases		6			4	
Actuated Green, G (s)	12.0	12.0	78.0		78.0	78.0
Effective Green, g (s)	12.0	12.0	78.0		78.0	78.0
Actuated g/C Ratio	0.12	0.12	0.78		0.78	0.78
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	212	190	2696		776	2760
v/s Ratio Prot	c0.07		0.10			0.16
v/s Ratio Perm		0.01			c0.17	
v/c Ratio	0.56	0.09	0.13		0.22	0.21
Uniform Delay, d1	41.5	39.1	2.7		2.9	2.9
Progression Factor	1.00	1.00	1.00		0.55	0.55
Incremental Delay, d2	3.1	0.2	0.1		0.6	0.2
Delay (s)	44.6	39.3	2.8		2.2	1.7
Level of Service	D	D	A		A	A
Approach Delay (s)	41.8		2.8			1.8
Approach LOS	D		A			A

Intersection Summary			
HCM Average Control Delay	9.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.27		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	37.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
11: Waverly Road & US 56 — PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	40	160	10	30	20	20	140	5	130	300	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	51	203	13	38	25	25	177	6	165	380	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	987	946	180	1171	946	383	386			184		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	987	946	180	1171	946	383	386			184		
tC, single (s)	7.1	6.5	6.3	7.2	6.5	6.2	4.1			4.2		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.4	3.6	4.0	3.3	2.2			2.3		
p0 queue free %	96	77	76	86	83	96	98			88		
cM capacity (veh/h)	170	223	845	92	223	658	1183			1322		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	259	76	209	551
Volume Left	6	13	25	165
Volume Right	203	25	6	6
cSH	515	219	1183	1322
Volume to Capacity	0.50	0.35	0.02	0.12
Queue Length 95th (ft)	70	37	2	11
Control Delay (s)	18.9	29.9	1.2	3.3
Lane LOS	C	D	A	A
Approach Delay (s)	18.9	29.9	1.2	3.3
Approach LOS	C	D		

Intersection Summary			
Average Delay	8.4		
Intersection Capacity Utilization	54.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
12: 183rd Street & Four Corners Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	10	5	0	10	10	5	5	0	5	5	5
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	11	5	0	11	11	5	5	0	5	5	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	22	22	11	16
Volume Left (vph)	5	0	5	5
Volume Right (vph)	5	11	0	5
Hadj (s)	-0.10	-0.30	0.10	-0.13
Departure Headway (s)	3.9	3.7	4.1	3.9
Degree Utilization, x	0.02	0.02	0.01	0.02
Capacity (veh/h)	915	965	855	916
Control Delay (s)	7.0	6.8	7.2	6.9
Approach Delay (s)	7.0	6.8	7.2	6.9
Approach LOS	A	A	A	A

Intersection Summary			
Delay	6.9		
HCM Level of Service	A		
Intersection Capacity Utilization	15.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

13: 183rd Street & US 56 — PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	5	0	0	170	320	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	0	0	215	405	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	620	405	405			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	620	405	405			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	99	100	100			
cM capacity (veh/h)	455	650	1165			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	6	215	405
Volume Left	6	0	0
Volume Right	0	0	0
cSH	455	1165	1700
Volume to Capacity	0.01	0.00	0.24
Queue Length 95th (ft)	1	0	0
Control Delay (s)	13.0	0.0	0.0
Lane LOS	B		
Approach Delay (s)	13.0	0.0	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	26.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

14: 183rd Street & Waverly Road — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	10	70	60	10	60	50
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	76	65	11	65	54
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	255	71			76	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	255	71			76	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	98	92			96	
cM capacity (veh/h)	706	998			1536	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	87	76	120
Volume Left	11	0	65
Volume Right	76	11	0
cSH	949	1700	1536
Volume to Capacity	0.09	0.04	0.04
Queue Length 95th (ft)	8	0	3
Control Delay (s)	9.2	0.0	4.2
Lane LOS	A		A
Approach Delay (s)	9.2	0.0	4.2
Approach LOS	A		

Intersection Summary			
Average Delay	4.6		
Intersection Capacity Utilization	24.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

15: 183rd Street & Gardner Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	40	80	60	50	50	120	310	130	70	280	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	2.5	2.5		2.5	2.5		2.5	2.5		2.5	2.5	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.90		1.00	0.92		1.00	0.96		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1752	1699		1770	1723		1787	3314		1787	3402	
Flt Permitted	0.56	1.00		0.50	1.00		0.50	1.00		0.45	1.00	
Satd. Flow (perm)	1038	1699		925	1723		950	3314		852	3402	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	45	45	90	67	56	56	135	348	146	79	315	56
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	45	135	0	67	112	0	135	494	0	79	371	0
Heavy Vehicles (%)	3%	0%	1%	2%	2%	2%	1%	5%	2%	1%	4%	2%
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	14.0	9.9		15.6	10.7		51.1	44.7		49.3	43.8	
Effective Green, g (s)	14.0	9.9		15.6	10.7		51.1	44.7		49.3	43.8	
Actuated g/C Ratio	0.19	0.13		0.21	0.14		0.68	0.60		0.66	0.58	
Clearance Time (s)	2.5	2.5		2.5	2.5		2.5	2.5		2.5	2.5	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	233	224		248	246		719	1975		629	1987	
v/s Ratio Prot	0.01	c0.08		c0.02	0.07		c0.02	c0.15		0.01	0.11	
v/s Ratio Perm	0.03			0.04			0.11			0.07		
v/c Ratio	0.19	0.60		0.27	0.46		0.19	0.25		0.13	0.19	
Uniform Delay, d1	27.2	30.7		27.2	29.5		4.2	7.2		4.6	7.3	
Progression Factor	1.00	1.00		1.00	1.00		0.75	0.77		1.00	1.00	
Incremental Delay, d2	0.4	4.5		0.6	1.3		0.1	0.3		0.1	0.0	
Delay (s)	27.7	35.3		27.8	30.8		3.2	5.8		4.7	7.3	
Level of Service	C	D		C	C		A	A		A	A	
Approach Delay (s)		33.4			29.7			5.2			6.9	
Approach LOS		C			C			A			A	

Intersection Summary			
HCM Average Control Delay	12.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.30		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	36.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

16: Four Corners Road & US 56 — PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	0	5	5	180	330	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	0	7	7	237	434	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	684	434	434			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	684	434	434			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	99	99			
cM capacity (veh/h)	415	626	1136			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	7	243	434
Volume Left	0	7	0
Volume Right	7	0	0
cSH	626	1136	1700
Volume to Capacity	0.01	0.01	0.26
Queue Length 95th (ft)	1	0	0
Control Delay (s)	10.8	0.3	0.0
Lane LOS	B	A	
Approach Delay (s)	10.8	0.3	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.2		
Intersection Capacity Utilization	27.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
17: 191st Street & US 56
PM Peak Hour

Movement	EBL	EBR	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	5	5	5	180	330	10
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	6	6	6	234	429	13
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	682	435	442			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	682	435	442			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	99	99			
cM capacity (veh/h)	416	625	1129			

Direction, Lane #	EB 1	NE 1	SW 1
Volume Total	13	240	442
Volume Left	6	6	0
Volume Right	6	0	13
cSH	500	1129	1700
Volume to Capacity	0.03	0.01	0.26
Queue Length 95th (ft)	2	0	0
Control Delay (s)	12.4	0.3	0.0
Lane LOS	B	A	
Approach Delay (s)	12.4	0.3	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	28.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
19: 191st Street & Waverly Road
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	50	200	0	5	210	20	5	5	5	20	5	40
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	54	217	0	5	228	22	5	5	5	22	5	43
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	250			217			622	587	217	584	576	239
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	250			217			622	587	217	584	576	239
tC, single (s)	4.3			4.1			7.1	6.5	6.2	7.3	6.5	6.5
tC, 2 stage (s)												
tF (s)	2.4			2.2			3.5	4.0	3.3	3.7	4.0	3.6
p0 queue free %	95			100			98	99	99	94	99	94
cM capacity (veh/h)	1207			1364			360	404	827	376	410	740

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	272	255	16	71
Volume Left	54	5	5	22
Volume Right	0	22	5	43
cSH	1207	1364	464	544
Volume to Capacity	0.05	0.00	0.04	0.13
Queue Length 95th (ft)	4	0	3	11
Control Delay (s)	2.0	0.2	13.0	12.6
Lane LOS	A	A	B	B
Approach Delay (s)	2.0	0.2	13.0	12.6
Approach LOS			B	B

Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	40.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
20: W 188th Street & Gardner Rd
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	10	220	20	10	20	220	610	20	20	480	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00			0.95			0.95	1.00
Frt	1.00	1.00	0.85		0.95			1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00		0.98			0.99			1.00	1.00
Satd. Flow (prot)	1805	1900	1137		1762			3052			3502	1538
Flt Permitted	0.72	1.00	1.00		0.87			0.69			0.91	1.00
Satd. Flow (perm)	1370	1900	1137		1571			2134			3180	1538
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	21	11	232	22	11	22	232	642	22	22	505	21
RTOR Reduction (vph)	0	0	202	0	19	0	0	2	0	0	0	5
Lane Group Flow (vph)	21	11	30	0	36	0	0	894	0	0	527	16
Heavy Vehicles (%)	0%	0%	42%	0%	0%	0%	52%	4%	0%	0%	3%	5%
Turn Type	Perm		Perm	Perm			Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	9.6	9.6	9.6		9.6			55.4			55.4	55.4
Effective Green, g (s)	9.6	9.6	9.6		9.6			55.4			55.4	55.4
Actuated g/C Ratio	0.13	0.13	0.13		0.13			0.74			0.74	0.74
Clearance Time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	175	243	146		201			1576			2349	1136
v/s Ratio Prot		0.01										
v/s Ratio Perm	0.02		c0.03		0.02			c0.42			0.17	0.01
v/c Ratio	0.12	0.05	0.20		0.18			0.57			0.22	0.01
Uniform Delay, d1	29.0	28.7	29.3		29.2			4.4			3.1	2.6
Progression Factor	1.00	1.00	1.00		1.00			0.90			1.54	2.19
Incremental Delay, d2	0.3	0.1	0.7		0.4			1.1			0.2	0.0
Delay (s)	29.3	28.8	30.0		29.6			5.1			5.0	5.7
Level of Service	C	C	C		C			A			A	A
Approach Delay (s)		29.9			29.6			5.1			5.0	
Approach LOS		C			C			A			A	

Intersection Summary			
HCM Average Control Delay	9.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	59.8%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
21: I-35 SB Ramps & Gardner Rd
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	170	0	640	10	210	0	0	600	120
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0		5.0		5.0			5.0	5.0
Lane Util. Factor				1.00		1.00		1.00			1.00	1.00
Frt				1.00		0.85		1.00			1.00	0.85
Flt Protected				0.95		1.00		1.00			1.00	1.00
Satd. Flow (prot)				1736		1346		1785			1638	1495
Flt Permitted				0.95		1.00		0.97			1.00	1.00
Satd. Flow (perm)				1736		1346		1739			1638	1495
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	181	0	681	11	223	0	0	638	128
RTOR Reduction (vph)	0	0	0	0	0	490	0	0	0	0	0	46
Lane Group Flow (vph)	0	0	0	181	0	191	0	234	0	0	638	82
Heavy Vehicles (%)	0%	0%	0%	4%	0%	20%	10%	6%	0%	0%	16%	8%
Turn Type				Prot		custom	Perm					Perm
Protected Phases				3				2			6	
Permitted Phases						3	2					6
Actuated Green, G (s)				16.7		16.7		48.3			48.3	48.3
Effective Green, g (s)				16.7		16.7		48.3			48.3	48.3
Actuated g/C Ratio				0.22		0.22		0.64			0.64	0.64
Clearance Time (s)				5.0		5.0		5.0			5.0	5.0
Vehicle Extension (s)				3.0		3.0		3.0			3.0	3.0
Lane Grp Cap (vph)				387		300		1120			1055	963
v/s Ratio Prot				0.10							c0.39	
v/s Ratio Perm						c0.14		0.13				0.06
v/c Ratio				0.47		0.64		0.21			0.60	0.09
Uniform Delay, d1				25.3		26.4		5.5			7.8	5.0
Progression Factor				1.00		1.00		0.70			0.69	0.33
Incremental Delay, d2				0.9		4.4		0.4			2.5	0.2
Delay (s)				26.2		30.8		4.2			7.8	1.8
Level of Service				C		C		A			A	A
Approach Delay (s)		0.0			29.8			4.2			6.8	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM Average Control Delay	17.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	59.6%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

22: I-35 NB Ramps & Gardner Rd

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	0	20	0	0	0	0	150	50	430	340	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.97						0.97			1.00	
Flt Protected		0.96						1.00			0.97	
Satd. Flow (prot)		1595						1778			1632	
Flt Permitted		0.96						1.00			0.71	
Satd. Flow (perm)		1595						1778			1190	
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	77	0	22	0	0	0	0	165	55	473	374	0
RTOR Reduction (vph)	0	14	0	0	0	0	0	11	0	0	0	0
Lane Group Flow (vph)	0	85	0	0	0	0	0	209	0	0	847	0
Heavy Vehicles (%)	13%	0%	5%	0%	0%	0%	0%	3%	4%	23%	1%	0%
Turn Type	Perm									Perm		
Protected Phases		4						2			6	
Permitted Phases	4									6		
Actuated Green, G (s)		5.6						59.4			59.4	
Effective Green, g (s)		5.6						59.4			59.4	
Actuated g/C Ratio		0.07						0.79			0.79	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		119						1408			942	
v/s Ratio Prot								0.12				
v/s Ratio Perm		0.05									c0.71	
v/c Ratio		0.72						0.15			0.90	
Uniform Delay, d1		33.9						1.8			5.6	
Progression Factor		1.00						1.00			1.00	
Incremental Delay, d2		18.4						0.2			11.7	
Delay (s)		52.3						2.1			17.4	
Level of Service		D						A			B	
Approach Delay (s)		52.3			0.0			2.1			17.4	
Approach LOS		D			A			A			B	

Intersection Summary			
HCM Average Control Delay	17.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	71.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

23: E 191st Street & Gardner Rd

PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	5	200	5	10	350
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	5	215	5	11	376
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						220
pX, platoon unblocked						
vC, conflicting volume	616	218			220	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	616	218			220	
tC, single (s)	6.4	6.4			4.2	
tC, 2 stage (s)						
tF (s)	3.5	3.5			2.3	
p0 queue free %	100	99			99	
cM capacity (veh/h)	454	779			1303	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	5	220	387
Volume Left	0	0	11
Volume Right	5	5	0
cSH	779	1700	1303
Volume to Capacity	0.01	0.13	0.01
Queue Length 95th (ft)	1	0	1
Control Delay (s)	9.7	0.0	0.3
Lane LOS	A		A
Approach Delay (s)	9.7	0.0	0.3
Approach LOS	A		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	36.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

24: Sunflower Road & US 56

PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	5	10	40	5	0	10	190	40	0	380	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	6	13	51	6	0	13	241	51	0	481	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	778	801	484	791	778	266	487			291		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	778	801	484	791	778	266	487			291		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	100	98	98	82	98	100	99			100		
cM capacity (veh/h)	308	316	587	287	326	778	1086			1282		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	19	57	304	487
Volume Left	0	51	13	0
Volume Right	13	0	51	6
cSH	457	291	1086	1282
Volume to Capacity	0.04	0.20	0.01	0.00
Queue Length 95th (ft)	3	18	1	0
Control Delay (s)	13.2	20.4	0.5	0.0
Lane LOS	B	C	A	
Approach Delay (s)	13.2	20.4	0.5	0.0
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	36.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

25: US 56 & 4th Street

PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	200	20	60	360	70	40
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	256	26	77	462	90	51
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			282		885	269
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			282		885	269
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			94		70	93
cM capacity (veh/h)			1292		298	774

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	282	538	141
Volume Left	0	77	90
Volume Right	26	0	51
cSH	1700	1292	384
Volume to Capacity	0.17	0.06	0.37
Queue Length 95th (ft)	0	5	41
Control Delay (s)	0.0	1.7	19.7
Lane LOS		A	C
Approach Delay (s)	0.0	1.7	19.7
Approach LOS			C

Intersection Summary			
Average Delay	3.8		
Intersection Capacity Utilization	50.3%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Gardner IMF Operations + Induced Development - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

26: 199th Street & Four Corners Road

PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	40	50	5	10	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	12	48	60	6	12	12
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	65				134	62
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	65				134	62
tC, single (s)	4.4				6.6	6.4
tC, 2 stage (s)						
tF (s)	2.5				3.7	3.5
p0 queue free %	99				99	99
cM capacity (veh/h)	1376				812	954

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	60	65	24
Volume Left	12	0	12
Volume Right	0	6	12
cSH	1376	1700	877
Volume to Capacity	0.01	0.04	0.03
Queue Length 95th (ft)	1	0	2
Control Delay (s)	1.6	0.0	9.2
Lane LOS	A		A
Approach Delay (s)	1.6	0.0	9.2
Approach LOS			A

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	19.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

27: 199th Street & Gardner Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	20	20	10	40	60	10	100	10	60	200	50
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	22	22	22	11	45	67	11	112	11	67	225	56

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	67	124	135	348
Volume Left (vph)	22	11	11	67
Volume Right (vph)	22	67	11	56
Hadj (s)	-0.08	-0.23	0.02	-0.02
Departure Headway (s)	5.2	4.9	4.8	4.5
Degree Utilization, x	0.10	0.17	0.18	0.44
Capacity (veh/h)	622	660	699	759
Control Delay (s)	8.7	8.9	8.9	11.1
Approach Delay (s)	8.7	8.9	8.9	11.1
Approach LOS	A	A	A	B

Intersection Summary			
Delay	10.0		
HCM Level of Service	B		
Intersection Capacity Utilization	38.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

28: I-35 SB Ramps & Sunflower Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	70	0	350	10	20	0	0	150	30
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	0	0	0	80	0	402	11	23	0	0	172	34
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	638	236	190	236	253	23	207			23		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	638	236	190	236	253	23	207			23		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.3			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.4			2.2		
p0 queue free %	100	100	100	89	100	62	99			100		
cM capacity (veh/h)	241	662	857	714	648	1057	1264			1605		

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	483	34	207
Volume Left	80	11	0
Volume Right	402	0	34
cSH	978	1264	1700
Volume to Capacity	0.49	0.01	0.12
Queue Length 95th (ft)	70	1	0
Control Delay (s)	12.2	2.7	0.0
Lane LOS	B	A	
Approach Delay (s)	12.2	2.7	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	8.3		
Intersection Capacity Utilization	42.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

29: I-35 NB Ramps & Sunflower Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	20	0	5	0	0	0	0	10	20	140	80	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	23	0	6	0	0	0	0	11	23	161	92	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	437	448	92	443	437	23	92			34		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	437	448	92	443	437	23	92			34		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	95	100	99	100	100	100	100			90		
cM capacity (veh/h)	491	456	971	484	463	1060	1515			1564		

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	29	34	253
Volume Left	23	0	161
Volume Right	6	23	0
cSH	545	1700	1564
Volume to Capacity	0.05	0.02	0.10
Queue Length 95th (ft)	4	0	9
Control Delay (s)	12.0	0.0	5.1
Lane LOS	B		A
Approach Delay (s)	12.0	0.0	5.1
Approach LOS	B		

Intersection Summary			
Average Delay	5.2		
Intersection Capacity Utilization	28.6%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Gardner IMF Operations + Induced Development - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
30: US-56 & I-35 NB Loop — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	540	1200	0	670	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	607	1348	0	753	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked						
vC, conflicting volume			1955		983	303
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1955		983	303
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			303		249	699

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	303	303	1348	376	376
Volume Left	0	0	0	0	0
Volume Right	0	0	1348	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.18	0.18	0.79	0.22	0.22
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	77.6%	ICU Level of Service	D
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
31: US 56 & Edgerton Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	140	20	40	270	10	20	10	10	20	10	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	152	22	43	293	11	22	11	11	22	11	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	304			174			571	565	163	576	571	299
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	304			174			571	565	163	576	571	299
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.2	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.6	4.0	3.3
p0 queue free %	100			97			95	97	99	95	97	99
cM capacity (veh/h)	1268			1397			412	421	887	397	418	745

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	179	348	43	38
Volume Left	5	43	22	22
Volume Right	22	11	11	5
cSH	1268	1397	479	432
Volume to Capacity	0.00	0.03	0.09	0.09
Queue Length 95th (ft)	0	2	7	7
Control Delay (s)	0.3	1.2	13.3	14.1
Lane LOS	A	A	B	B
Approach Delay (s)	0.3	1.2	13.3	14.1
Approach LOS			B	B

Intersection Summary			
Average Delay	2.6		
Intersection Capacity Utilization	39.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
32: 207th & Sunflower Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	0	50	5	5	10	100	170	5	5	180	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	0	63	6	6	13	127	215	6	6	228	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	731	718	231	778	718	218	234			222		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	731	718	231	778	718	218	234			222		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	100	92	98	98	98	91			100		
cM capacity (veh/h)	305	322	801	269	322	826	1339			1359		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	70	25	348	241
Volume Left	6	6	127	6
Volume Right	63	13	6	6
cSH	698	433	1339	1359
Volume to Capacity	0.10	0.06	0.09	0.00
Queue Length 95th (ft)	8	5	8	0
Control Delay (s)	10.7	13.8	3.4	0.2
Lane LOS	B	B	A	A
Approach Delay (s)	10.7	13.8	3.4	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	3.4		
Intersection Capacity Utilization	38.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
33: 207th & COOP Rd — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	40	70	40	20	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	14	54	95	54	27	14
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	149				203	122
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	149				203	122
tC, single (s)	4.1				6.5	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.6	3.3
p0 queue free %	99				96	99
cM capacity (veh/h)	1445				767	935

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	68	149	41
Volume Left	14	0	27
Volume Right	0	54	14
cSH	1445	1700	816
Volume to Capacity	0.01	0.09	0.05
Queue Length 95th (ft)	1	0	4
Control Delay (s)	1.6	0.0	9.6
Lane LOS	A		A
Approach Delay (s)	1.6	0.0	9.6
Approach LOS			A

Intersection Summary			
Average Delay	1.9		
Intersection Capacity Utilization	19.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

34: 207th & Edgerton Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	10	0	10	10	60	5	5	5	30	5	10
Peak Hour Factor	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Hourly flow rate (vph)	8	15	0	15	15	91	8	8	8	45	8	15

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	23	121	23	68
Volume Left (vph)	8	15	8	45
Volume Right (vph)	0	91	8	15
Hadj (s)	0.07	-0.06	0.01	0.12
Departure Headway (s)	4.3	4.1	4.3	4.4
Degree Utilization, x	0.03	0.14	0.03	0.08
Capacity (veh/h)	811	863	799	798
Control Delay (s)	7.4	7.7	7.4	7.7
Approach Delay (s)	7.4	7.7	7.4	7.7
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.7		
HCM Level of Service	A		
Intersection Capacity Utilization	16.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

35: 207th & Evening Star Rd — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	10	5	5	10	5	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	20	10	10	20	10	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			30		65	25
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			30		65	25
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		99	99
cM capacity (veh/h)			1596		940	1057

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	30	30	20
Volume Left	0	10	10
Volume Right	10	0	10
cSH	1700	1596	995
Volume to Capacity	0.02	0.01	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	2.5	8.7
Lane LOS		A	A
Approach Delay (s)	0.0	2.5	8.7
Approach LOS			A

Intersection Summary			
Average Delay	3.1		
Intersection Capacity Utilization	15.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

36: 215th & Evening Star Rd — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	5	5	0	5	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	10	10	0	10	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	10				20	10
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	10				20	10
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	99
cM capacity (veh/h)	1623				1002	1077

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	10	10	20
Volume Left	0	0	10
Volume Right	0	0	10
cSH	1623	1700	1038
Volume to Capacity	0.00	0.01	0.02
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	0.0	8.5
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.5
Approach LOS			A

Intersection Summary			
Average Delay	4.3		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

42: US 56 & 175th Street — PM Peak Hour

Intersection Sign configuration not allowed in HCM analysis.

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
51: 175th Street & — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	0	0	0	0	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	0	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			0		0	0
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			0		0	0
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			1623		1023	1085

Direction, Lane #	EB 1	EB 2	WB 1	NB 1
Volume Total	0	0	0	0
Volume Left	0	0	0	0
Volume Right	0	0	0	0
cSH	1700	1700	1700	1700
Volume to Capacity	0.00	0.00	0.00	0.00
Queue Length 95th (ft)	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0
Lane LOS				A
Approach Delay (s)	0.0		0.0	0.0
Approach LOS				A

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	0.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
55: US 56 & — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	0	0	0	0	0
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	0	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	0				0	0
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	0				0	0
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	100
cM capacity (veh/h)	1622				1023	1084

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	0	0	0	0	0
Volume Left	0	0	0	0	0
Volume Right	0	0	0	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.00	0.00	0.00	0.00	0.00
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					A
Approach Delay (s)	0.0		0.0		0.0
Approach LOS					A

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
80: 191st Street & Driveway A — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	5	10	110	90	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	11	120	98	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	130				87	71
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	130				87	71
tC, single (s)	5.1				7.4	7.2
tC, 2 stage (s)						
tF (s)	3.1				4.4	4.2
p0 queue free %	99				86	99
cM capacity (veh/h)	1021				717	775

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	11	130	98	5
Volume Left	5	0	98	0
Volume Right	0	120	0	5
cSH	1021	1700	717	775
Volume to Capacity	0.01	0.08	0.14	0.01
Queue Length 95th (ft)	0	0	12	1
Control Delay (s)	4.3	0.0	10.8	9.7
Lane LOS	A		B	A
Approach Delay (s)	4.3	0.0	10.7	
Approach LOS			B	

Intersection Summary			
Average Delay	4.7		
Intersection Capacity Utilization	19.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects
81: 191st Street & Driveway B — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	90	110	130	150	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	98	120	141	163	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	261				310	190
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	261				310	190
tC, single (s)	4.6				6.5	6.6
tC, 2 stage (s)						
tF (s)	2.7				3.6	3.7
p0 queue free %	99				75	99
cM capacity (veh/h)	1070				665	763

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	109	261	163	11
Volume Left	11	0	163	0
Volume Right	0	141	0	11
cSH	1070	1700	665	763
Volume to Capacity	0.01	0.15	0.25	0.01
Queue Length 95th (ft)	1	0	24	1
Control Delay (s)	0.9	0.0	12.2	9.8
Lane LOS	A		B	A
Approach Delay (s)	0.9	0.0	12.0	
Approach LOS			B	

Intersection Summary			
Average Delay	4.0		
Intersection Capacity Utilization	28.7%	ICU Level of Service	A
Analysis Period (min)	15		

82: Driveway C & Waverly Road

PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	5	5	5	60	60	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	5	65	65	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	144	68	71			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	144	68	71			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	99	99	100			
cM capacity (veh/h)	850	1001	1543			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	5	5	71	71
Volume Left	5	0	5	0
Volume Right	0	5	0	5
cSH	850	1001	1543	1700
Volume to Capacity	0.01	0.01	0.00	0.04
Queue Length 95th (ft)	0	0	0	0
Control Delay (s)	9.3	8.6	0.6	0.0
Lane LOS	A	A	A	
Approach Delay (s)	8.9		0.6	0.0
Approach LOS	A			

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	17.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

83: Driveway D & Waverly Road

PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	150	80	70	50	40	120
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	163	87	76	54	43	130
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	315	109	174			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	315	109	174			
tC, single (s)	6.5	6.3	4.3			
tC, 2 stage (s)						
tF (s)	3.6	3.4	2.3			
p0 queue free %	74	91	94			
cM capacity (veh/h)	629	921	1322			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	163	87	130	174
Volume Left	163	0	76	0
Volume Right	0	87	0	130
cSH	629	921	1322	1700
Volume to Capacity	0.26	0.09	0.06	0.10
Queue Length 95th (ft)	26	8	5	0
Control Delay (s)	12.7	9.3	4.8	0.0
Lane LOS	B	A	A	
Approach Delay (s)	11.5		4.8	0.0
Approach LOS	B			

Intersection Summary			
Average Delay	6.3		
Intersection Capacity Utilization	34.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects

84: 191st Street & Driveway E

PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	95	115	5	5	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	103	125	5	5	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	130				242	128
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	130				242	128
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	99
cM capacity (veh/h)	1467				748	928

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	109	130	11
Volume Left	5	0	5
Volume Right	0	5	5
cSH	1467	1700	828
Volume to Capacity	0.00	0.08	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.4	0.0	9.4
Lane LOS	A		A
Approach Delay (s)	0.4	0.0	9.4
Approach LOS			A

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	19.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

1: 175th Street & Waverly Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	70	330	20	0	60	60	10	100	5	100	50	20
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	84	398	24	0	72	72	12	120	6	120	60	24

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	506	145	139	205
Volume Left (vph)	84	0	12	120
Volume Right (vph)	24	72	6	24
Hadj (s)	0.07	-0.23	0.04	0.12
Departure Headway (s)	5.3	5.6	6.2	6.1
Degree Utilization, x	0.75	0.22	0.24	0.35
Capacity (veh/h)	658	574	507	530
Control Delay (s)	22.1	10.2	11.1	12.3
Approach Delay (s)	22.1	10.2	11.1	12.3
Approach LOS	C	B	B	B

Intersection Summary			
Delay	16.8		
HCM Level of Service	C		
Intersection Capacity Utilization	51.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

2: US 56 & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	670	70	110	390	120	80	370	220	160	240	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.99			0.97		1.00	0.94		1.00	0.97	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3341			3234		1805	1725		1736	1779	
Flt Permitted		0.82			0.56		0.50	1.00		0.20	1.00	
Satd. Flow (perm)		2760			1829		943	1725		358	1779	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	57	770	80	126	448	138	92	425	253	184	276	69
RTOR Reduction (vph)	0	9	0	0	28	0	0	29	0	0	12	0
Lane Group Flow (vph)	0	898	0	0	684	0	92	649	0	184	333	0
Heavy Vehicles (%)	4%	7%	1%	7%	8%	6%	0%	4%	4%	4%	4%	2%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		28.1			28.1		35.2	35.2		35.2	35.2	
Effective Green, g (s)		28.1			28.1		35.2	35.2		35.2	35.2	
Actuated g/C Ratio		0.37			0.37		0.47	0.47		0.47	0.47	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1034			685		443	810		168	835	
v/s Ratio Prot								0.38			0.19	
v/s Ratio Perm		0.33			c0.37		0.10			c0.51		
v/c Ratio		0.87			1.00		0.21	0.80		1.10	0.40	
Uniform Delay, d1		21.7			23.4		11.7	16.9		19.9	13.0	
Progression Factor		1.00			0.40		1.00	1.00		1.00	1.00	
Incremental Delay, d2		9.8			33.7		0.2	5.7		97.2	0.3	
Delay (s)		31.6			43.1		11.9	22.7		117.1	13.3	
Level of Service		C			D		B	C		F	B	
Approach Delay (s)		31.6			43.1			21.4			49.4	
Approach LOS		C			D			C			D	

Intersection Summary			
HCM Average Control Delay	34.9	HCM Level of Service	C
HCM Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	11.7
Intersection Capacity Utilization	101.3%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

3: US 56 & Elm — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	1030	10	10	580	50	10	5	30	80	10	30
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			0.99			0.91			0.97	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3582			3499			1799			1857	
Flt Permitted		0.94			0.94			0.94			0.81	
Satd. Flow (perm)		3357			3275			1714			1559	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	22	1108	11	11	624	54	11	5	32	86	11	32
RTOR Reduction (vph)	0	0	0	0	5	0	0	28	0	0	21	0
Lane Group Flow (vph)	0	1141	0	0	684	0	0	20	0	0	108	0
Heavy Vehicles (%)	0%	6%	0%	0%	8%	0%	0%	0%	0%	0%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		56.3			56.3			9.7			9.7	
Effective Green, g (s)		56.3			56.3			9.7			9.7	
Actuated g/C Ratio		0.75			0.75			0.13			0.13	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2520			2458			222			202	
v/s Ratio Prot												
v/s Ratio Perm		c0.34			0.21			0.01			c0.07	
v/c Ratio		0.45			0.28			0.09			0.54	
Uniform Delay, d1		3.5			2.9			28.8			30.5	
Progression Factor		0.45			0.81			1.00			1.00	
Incremental Delay, d2		0.3			0.1			0.2			2.7	
Delay (s)		1.9			2.5			28.9			33.3	
Level of Service		A			A			C			C	
Approach Delay (s)		1.9			2.5			28.9			33.3	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	4.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.46		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	61.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

4: US 56 & Mulberry — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	1120	10	10	580	60	5	5	20	100	5	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			0.99			0.91			0.97	
Flt Protected		1.00			1.00			0.99			0.96	
Satd. Flow (prot)		3429			3297			1605			1740	
Flt Permitted		0.91			0.93			0.95			0.76	
Satd. Flow (perm)		3123			3077			1545			1372	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	43	1204	11	11	624	65	5	5	22	108	5	32
RTOR Reduction (vph)	0	1	0	0	9	0	0	19	0	0	14	0
Lane Group Flow (vph)	0	1257	0	0	691	0	0	13	0	0	131	0
Heavy Vehicles (%)	5%	5%	0%	0%	8%	8%	0%	20%	5%	2%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		54.1			54.1			11.9			11.9	
Effective Green, g (s)		54.1			54.1			11.9			11.9	
Actuated g/C Ratio		0.72			0.72			0.16			0.16	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2253			2220			245			218	
v/s Ratio Prot												
v/s Ratio Perm		c0.40			0.22			0.01			c0.10	
v/c Ratio		0.56			0.31			0.06			0.60	
Uniform Delay, d1		4.9			3.8			26.8			29.3	
Progression Factor		0.79			0.66			1.00			1.00	
Incremental Delay, d2		0.9			0.1			0.1			4.4	
Delay (s)		4.8			2.6			26.9			33.7	
Level of Service		A			A			C			C	
Approach Delay (s)		4.8			2.6			26.9			33.7	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	6.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	82.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
5: US 56 & Moonlight Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	1070	150	40	460	180	150	130	130	490	170	60
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1719	3585	1568	1752	3312	1583	1770	3539	1538	3433	3505	1538
Flt Permitted	0.42	1.00	1.00	0.15	1.00	1.00	0.63	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	751	3585	1568	276	3312	1583	1181	3539	1538	3433	3505	1538
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	88	1176	165	44	505	198	165	143	143	538	187	66
RTOR Reduction (vph)	0	0	104	0	0	128	0	0	128	0	0	56
Lane Group Flow (vph)	88	1176	61	44	505	70	165	143	15	538	187	10
Heavy Vehicles (%)	5%	6%	3%	3%	9%	2%	2%	2%	5%	2%	3%	5%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	Prot		Perm
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6	8		8			4
Actuated Green, G (s)	32.7	27.9	27.9	30.3	26.7	26.7	16.7	8.0	8.0	12.5	11.8	11.8
Effective Green, g (s)	32.7	27.9	27.9	30.3	26.7	26.7	16.7	8.0	8.0	12.5	11.8	11.8
Actuated g/C Ratio	0.44	0.37	0.37	0.40	0.36	0.36	0.22	0.11	0.11	0.17	0.16	0.16
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	389	1334	583	182	1179	564	331	377	164	572	551	242
v/s Ratio Prot	c0.01	c0.33		0.01	0.15		0.06	0.04		c0.16	c0.05	
v/s Ratio Perm	0.08		0.04	0.09		0.04	c0.05		0.01			0.01
v/c Ratio	0.23	0.88	0.11	0.24	0.43	0.12	0.50	0.38	0.09	0.94	0.34	0.04
Uniform Delay, d1	12.6	22.0	15.4	15.7	18.4	16.3	25.0	31.2	30.2	30.9	28.1	26.8
Progression Factor	0.51	0.63	0.44	0.71	0.96	1.66	0.95	0.92	0.75	1.00	1.00	1.00
Incremental Delay, d2	0.1	7.7	0.3	0.2	1.1	0.4	0.4	0.2	0.1	23.6	0.1	0.0
Delay (s)	6.6	21.5	7.0	11.4	18.7	27.4	24.1	29.1	22.9	54.5	28.3	26.8
Level of Service	A	C	A	B	B	C	C	C	C	D	C	C
Approach Delay (s)		18.9			20.6			25.3			46.0	
Approach LOS		B			C			C			D	

Intersection Summary			
HCM Average Control Delay	26.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	72.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
6: Old US 56 & US 56 — AM Peak Hour

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	60	10	1450	240	10	650
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	4.0	5.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1615	3619	1568	1805	3551
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1615	3619	1568	1805	3551
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	62	10	1495	247	10	670
RTOR Reduction (vph)	0	8	0	94	0	0
Lane Group Flow (vph)	62	2	1495	153	10	670
Heavy Vehicles (%)	2%	0%	5%	3%	0%	7%
Turn Type		Perm		custom	Prot	
Protected Phases	8		2	4	1	6
Permitted Phases		8				
Actuated Green, G (s)	11.3	11.3	48.3	11.3	1.4	53.7
Effective Green, g (s)	11.3	11.3	48.3	11.3	1.4	53.7
Actuated g/C Ratio	0.15	0.15	0.64	0.15	0.02	0.72
Clearance Time (s)	5.0	5.0	5.0	5.0	4.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	267	243	2331	236	34	2543
v/s Ratio Prot	0.04		c0.41	c0.10	0.01	c0.19
v/s Ratio Perm		0.00				
v/c Ratio	0.23	0.01	0.64	0.65	0.29	0.26
Uniform Delay, d1	28.0	27.1	8.1	30.0	36.3	3.7
Progression Factor	1.00	1.00	0.51	1.72	1.00	1.00
Incremental Delay, d2	0.4	0.0	0.7	3.2	4.8	0.3
Delay (s)	28.5	27.1	4.9	54.8	41.1	4.0
Level of Service	C	C	A	D	D	A
Approach Delay (s)	28.3		12.0			4.5
Approach LOS	C		B			A

Intersection Summary			
HCM Average Control Delay	10.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	52.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
7: US-56 & Cedar Niles — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	1490	110	270	1380	70	90	20	510	40	10	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00		1.00	0.88	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85	1.00	0.88	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1805	3689	1615	3433	3654	1615		1825	2842	1752	1606	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.73	1.00	0.64	1.00	
Satd. Flow (perm)	1805	3689	1615	3433	3654	1615		1379	2842	1189	1606	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	56	1674	124	303	1551	79	101	22	573	45	11	45
RTOR Reduction (vph)	0	0	53	0	0	29	0	0	0	0	39	0
Lane Group Flow (vph)	56	1674	71	303	1551	50	0	123	573	45	17	0
Heavy Vehicles (%)	0%	3%	0%	2%	4%	0%	0%	0%	0%	3%	0%	5%
Turn Type	Prot		Perm	Prot		Perm	Perm		pt+ov	Perm		
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases			2			6	8			4		
Actuated Green, G (s)	6.4	51.2	51.2	11.8	56.6	56.6		11.4	27.2	11.4	11.4	
Effective Green, g (s)	6.4	51.2	51.2	11.8	56.6	56.6		11.4	23.2	11.4	11.4	
Actuated g/C Ratio	0.07	0.57	0.57	0.13	0.63	0.63		0.13	0.26	0.13	0.13	
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2		5.2	5.2	
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0		1.0		1.0	1.0	
Lane Grp Cap (vph)	128	2099	919	450	2298	1016		175	733	151	203	
v/s Ratio Prot	0.03	c0.45		0.09	0.42				c0.20		0.01	
v/s Ratio Perm			0.04			0.03		0.09		0.04		
v/c Ratio	0.44	0.80	0.08	0.67	0.67	0.05		0.70	0.78	0.30	0.08	
Uniform Delay, d1	40.1	15.3	8.7	37.3	10.8	6.4		37.7	31.0	35.7	34.7	
Progression Factor	1.00	1.00	1.00	0.83	0.64	0.94		1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.9	3.3	0.2	1.9	1.0	0.1		10.0	5.0	0.4	0.1	
Delay (s)	40.9	18.6	8.9	32.7	7.8	6.1		47.6	36.1	36.1	34.7	
Level of Service	D	B	A	C	A	A		D	D	D	C	
Approach Delay (s)		18.6			11.7			38.1			35.3	
Approach LOS		B			B			D			D	

Intersection Summary			
HCM Average Control Delay	19.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	16.8
Intersection Capacity Utilization	79.3%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
8: US-56 & I-35 SB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1990	50	50	550	0	0	0	0	60	0	1160
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		1.00		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3513		1671	3689					1641		2760
Flt Permitted		1.00		0.95	1.00					0.95		1.00
Satd. Flow (perm)		3513		1671	3689					1641		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2095	53	53	579	0	0	0	0	63	0	1221
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	2146	0	53	579	0	0	0	0	63	0	1221
Heavy Vehicles (%)	0%	2%	18%	8%	3%	0%	0%	0%	0%	10%	0%	3%
Turn Type				Prot						Prot		custom
Protected Phases		2		1	6					7		5
Permitted Phases												4
Actuated Green, G (s)		65.2		4.2	28.4					5.6		41.0
Effective Green, g (s)		65.2		4.2	28.4					5.6		41.0
Actuated g/C Ratio		0.72		0.05	0.32					0.06		0.46
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2545		78	1164					102		1257
v/s Ratio Prot		c0.61		0.03	c0.16					c0.04		c0.44
v/s Ratio Perm												
v/c Ratio		0.84		0.68	0.50					0.62		0.97
Uniform Delay, d1		8.8		42.2	25.0					41.2		23.9
Progression Factor		0.64		0.97	0.84					1.00		1.00
Incremental Delay, d2		2.4		18.0	1.3					10.6		18.8
Delay (s)		8.0		59.0	22.4					51.8		42.7
Level of Service		A		E	C					D		D
Approach Delay (s)		8.0			25.4			0.0			43.2	
Approach LOS		A			C			A			D	

Intersection Summary			
HCM Average Control Delay	21.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	67.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

2015 Gardner IMF Operations + Induced Development - (Mitigated) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
9: US-56 & I-35 NB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑			✥			✥				
Volume (vph)	0	400	0	0	430	140	170	0	110	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			0.97			0.95				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3689			1801			1629				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3689			1801			1629				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	455	0	0	489	159	193	0	125	0	0	0
RTOR Reduction (vph)	0	0	0	0	10	0	0	29	0	0	0	0
Lane Group Flow (vph)	0	455	0	0	638	0	0	289	0	0	0	0
Heavy Vehicles (%)	0%	3%	0%	0%	2%	2%	8%	0%	6%	0%	0%	0%
Turn Type				Perm			Perm					
Protected Phases		2			6			8				
Permitted Phases				6			8					
Actuated Green, G (s)		59.0			59.0			21.0				
Effective Green, g (s)		59.0			59.0			21.0				
Actuated g/C Ratio		0.66			0.66			0.23				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		2418			1181			380				
v/s Ratio Prot		0.12			c0.35							
v/s Ratio Perm								0.18				
v/c Ratio		0.19			0.54			0.76				
Uniform Delay, d1		6.1			8.3			32.2				
Progression Factor		0.31			1.00			1.00				
Incremental Delay, d2		0.1			1.8			8.7				
Delay (s)		2.0			10.0			40.8				
Level of Service		A			B			D				
Approach Delay (s)		2.0			10.0			40.8			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	14.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	105.5%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
10: Sante Fe & Moonlight — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰	↱	↑↱		↰	↑↑
Volume (vph)	50	110	300	80	140	220
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.97		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3408		1787	3471
Flt Permitted	0.95	1.00	1.00		0.51	1.00
Satd. Flow (perm)	1770	1583	3408		963	3471
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	54	118	323	86	151	237
RTOR Reduction (vph)	0	107	18	0	0	0
Lane Group Flow (vph)	54	11	391	0	151	237
Heavy Vehicles (%)	2%	2%	3%	1%	1%	4%
Turn Type		Perm			Perm	
Protected Phases	6		8			4
Permitted Phases		6			4	
Actuated Green, G (s)	6.8	6.8	58.2		58.2	58.2
Effective Green, g (s)	6.8	6.8	58.2		58.2	58.2
Actuated g/C Ratio	0.09	0.09	0.78		0.78	0.78
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	160	144	2645		747	2693
v/s Ratio Prot	c0.03		0.11			0.07
v/s Ratio Perm		0.01			c0.16	
v/c Ratio	0.34	0.07	0.15		0.20	0.09
Uniform Delay, d1	32.0	31.2	2.1		2.2	2.0
Progression Factor	1.00	1.00	1.00		0.98	0.85
Incremental Delay, d2	1.3	0.2	0.1		0.6	0.1
Delay (s)	33.2	31.4	2.2		2.8	1.8
Level of Service	C	C	A		A	A
Approach Delay (s)	32.0		2.2			2.2
Approach LOS	C		A			A

Intersection Summary			
HCM Average Control Delay	7.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.22		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	36.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
11: Waverly Road & US 56 — AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✥			✥			✥			✥	
Volume (vph)	5	30	50	10	50	10	70	290	10	190	90	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.92			0.98			1.00			1.00	
Flt Protected		1.00			0.99			0.99			0.97	
Satd. Flow (prot)		1455			1797			1781			1667	
Flt Permitted		0.97			0.93			0.88			0.59	
Satd. Flow (perm)		1418			1679			1574			1014	
Peak-hour factor, PHF	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Adj. Flow (vph)	6	38	63	13	63	13	89	367	13	241	114	13
RTOR Reduction (vph)	0	56	0	0	10	0	0	1	0	0	2	0
Lane Group Flow (vph)	0	51	0	0	79	0	0	468	0	0	366	0
Heavy Vehicles (%)	0%	3%	32%	0%	2%	10%	3%	6%	0%	7%	17%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2	2		6		
Actuated Green, G (s)		4.7			4.7			26.0			26.0	
Effective Green, g (s)		4.7			4.7			26.0			26.0	
Actuated g/C Ratio		0.12			0.12			0.64			0.64	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		164			194			1006			648	
v/s Ratio Prot												
v/s Ratio Perm		0.04			c0.05			0.30			c0.36	
v/c Ratio		0.31			0.41			0.46			0.57	
Uniform Delay, d1		16.5			16.7			3.8			4.2	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		1.1			1.4			0.3			1.1	
Delay (s)		17.6			18.1			4.1			5.3	
Level of Service		B			B			A			A	
Approach Delay (s)		17.6			18.1			4.1			5.3	
Approach LOS		B			B			A			A	

Intersection Summary			
HCM Average Control Delay	7.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	40.7	Sum of lost time (s)	10.0
Intersection Capacity Utilization	54.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
12: 183rd Street & Four Corners Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✥			✥			✥			✥	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	10	5	5	10	10	10	10	5	5	10	5
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	11	5	5	11	11	11	11	5	5	11	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	22	27	27	22
Volume Left (vph)	5	5	11	5
Volume Right (vph)	5	11	5	5
Hadj (s)	-0.10	-0.20	-0.04	-0.10
Departure Headway (s)	3.9	3.8	4.0	3.9
Degree Utilization, x	0.02	0.03	0.03	0.02
Capacity (veh/h)	898	924	880	900
Control Delay (s)	7.0	6.9	7.1	7.0
Approach Delay (s)	7.0	6.9	7.1	7.0
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.0		
HCM Level of Service	A		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

13: 183rd Street & US 56 — AM Peak Hour

Intersection Sign configuration not allowed in HCM analysis.

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

14: 183rd Street & Waverly Road — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	20	90	50	20	10	80
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	22	98	54	22	11	87
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	174	65			76	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	174	65			76	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	97	90			99	
cM capacity (veh/h)	815	1004			1536	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	120	76	98
Volume Left	22	0	11
Volume Right	98	22	0
cSH	964	1700	1536
Volume to Capacity	0.12	0.04	0.01
Queue Length 95th (ft)	11	0	1
Control Delay (s)	9.3	0.0	0.9
Lane LOS	A		A
Approach Delay (s)	9.3	0.0	0.9
Approach LOS	A		

Intersection Summary			
Average Delay	4.1		
Intersection Capacity Utilization	24.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

15: 183rd Street & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	20	110	130	30	110	90	480	50	40	400	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	2.5	2.5		2.5	2.5		2.5	2.5		2.5	2.5	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.87		1.00	0.88		1.00	0.99		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1805	1658		1805	1676		1805	3435		1805	3485	
Flt Permitted	0.63	1.00		0.35	1.00		0.45	1.00		0.39	1.00	
Satd. Flow (perm)	1203	1658		662	1676		853	3435		734	3485	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	56	22	124	146	34	124	101	539	56	45	449	22
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	56	146	0	146	158	0	101	595	0	45	471	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	4%	0%	0%	3%	0%
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	22.8	15.9		31.2	21.8		78.8	71.9		73.2	68.8	
Effective Green, g (s)	22.8	15.9		31.2	21.8		78.8	71.9		73.2	68.8	
Actuated g/C Ratio	0.20	0.14		0.27	0.19		0.69	0.63		0.64	0.60	
Clearance Time (s)	2.5	2.5		2.5	2.5		2.5	2.5		2.5	2.5	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	275	229		307	318		647	2148		508	2085	
v/s Ratio Prot	0.01	c0.09		c0.05	0.09		c0.01	c0.17		0.00	0.14	
v/s Ratio Perm	0.03			0.08			0.10			0.05		
v/c Ratio	0.20	0.64		0.48	0.50		0.16	0.28		0.09	0.23	
Uniform Delay, d1	38.1	46.8		33.6	41.7		8.2	9.8		10.8	10.7	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.4	5.7		1.2	1.2		0.1	0.3		0.1	0.1	
Delay (s)	38.5	52.5		34.8	42.9		8.4	10.1		10.8	10.8	
Level of Service	D	D		C	D		A	B		B	B	
Approach Delay (s)		48.7			39.0			9.8			10.8	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM Average Control Delay	19.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.35		
Actuated Cycle Length (s)	115.0	Sum of lost time (s)	7.5
Intersection Capacity Utilization	46.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

16: Four Corners Road & US 56 — AM Peak Hour

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	0	10	10	370	110	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	0	13	13	487	145	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	658	145	145			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	658	145	145			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	99	99			
cM capacity (veh/h)	428	908	1450			

Direction, Lane #	SB 1	NE 1	SW 1
Volume Total	13	500	145
Volume Left	0	13	0
Volume Right	13	0	0
cSH	908	1450	1700
Volume to Capacity	0.01	0.01	0.09
Queue Length 95th (ft)	1	1	0
Control Delay (s)	9.0	0.3	0.0
Lane LOS	A	A	
Approach Delay (s)	9.0	0.3	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	36.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
17: 191st Street & US 56 AM Peak Hour

Intersection Sign configuration not allowed in HCM analysis.

BNSF NEPA Traffic Study 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
19: 191st Street & Waverly Road AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	20	140	5	5	220	50	5	5	5	40	5	60
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	22	152	5	5	239	54	5	5	5	43	5	65
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	293			158			543	503	155	484	478	266
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	293			158			543	503	155	484	478	266
tC, single (s)	4.6			4.1			7.1	6.5	6.2	7.2	6.5	6.4
tC, 2 stage (s)												
tF (s)	2.7			2.2			3.5	4.0	3.3	3.6	4.0	3.4
p0 queue free %	98			100			99	99	99	91	99	91
cM capacity (veh/h)	1038			1434			402	462	896	460	477	742

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	179	299	16	114
Volume Left	22	5	5	43
Volume Right	5	54	5	65
cSH	1038	1434	520	589
Volume to Capacity	0.02	0.00	0.03	0.19
Queue Length 95th (ft)	2	0	2	18
Control Delay (s)	1.2	0.2	12.1	12.6
Lane LOS	A	A	B	B
Approach Delay (s)	1.2	0.2	12.1	12.6
Approach LOS			B	B

Intersection Summary			
Average Delay	3.1		
Intersection Capacity Utilization	34.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
20: W 188th Street & Gardner Rd AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	5	180	10	5	10	240	330	5	5	570	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00			0.95			0.95	1.00
Frt	1.00	1.00	0.85		0.94			1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00		0.98			0.98			1.00	1.00
Satd. Flow (prot)	1805	1900	1049		1760			3071			3538	1538
Flt Permitted	0.74	1.00	1.00		0.89			0.61			0.95	1.00
Satd. Flow (perm)	1405	1900	1049		1593			1912			3368	1538
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	11	5	189	11	5	11	253	347	5	5	600	21
RTOR Reduction (vph)	0	0	169	0	10	0	0	0	0	0	0	5
Lane Group Flow (vph)	11	5	20	0	17	0	0	605	0	0	605	16
Heavy Vehicles (%)	0%	0%	54%	0%	0%	0%	29%	5%	0%	0%	2%	5%
Turn Type	Perm		Perm	Perm			Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	9.6	9.6	9.6		9.6			70.4			70.4	70.4
Effective Green, g (s)	9.6	9.6	9.6		9.6			70.4			70.4	70.4
Actuated g/C Ratio	0.11	0.11	0.11		0.11			0.78			0.78	0.78
Clearance Time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	150	203	112		170			1496			2635	1203
v/s Ratio Prot		0.00										
v/s Ratio Perm	0.01		c0.02		0.01			c0.32			0.18	0.01
v/c Ratio	0.07	0.02	0.18		0.10			0.40			0.23	0.01
Uniform Delay, d1	36.2	36.0	36.6		36.3			3.1			2.6	2.2
Progression Factor	1.00	1.00	1.00		1.00			0.99			1.00	1.00
Incremental Delay, d2	0.2	0.0	0.8		0.3			0.8			0.2	0.0
Delay (s)	36.4	36.1	37.4		36.6			3.9			2.8	2.2
Level of Service	D	D	D		D			A			A	A
Approach Delay (s)		37.3			36.6			3.9			2.8	
Approach LOS		D			D			A			A	

Intersection Summary			
HCM Average Control Delay	8.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	52.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
21: I-35 SB Ramps & Gardner Rd AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	40	0	290	10	290	0	0	700	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0		5.0		5.0			5.0	5.0
Lane Util. Factor				1.00		1.00		1.00			1.00	1.00
Frt				1.00		0.85		1.00			1.00	0.85
Flt Protected				0.95		1.00		1.00			1.00	1.00
Satd. Flow (prot)				1671		1282		1826			1667	1442
Flt Permitted				0.95		1.00		0.98			1.00	1.00
Satd. Flow (perm)				1671		1282		1785			1667	1442
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	43	0	309	11	309	0	0	745	64
RTOR Reduction (vph)	0	0	0	0	0	274	0	0	0	0	0	14
Lane Group Flow (vph)	0	0	0	43	0	35	0	320	0	0	745	50
Heavy Vehicles (%)	0%	0%	0%	8%	0%	26%	0%	4%	0%	0%	14%	12%
Turn Type				Prot		custom	Perm					Perm
Protected Phases				3				2			6	
Permitted Phases						3	2					6
Actuated Green, G (s)				10.1		10.1		69.9			69.9	69.9
Effective Green, g (s)				10.1		10.1		69.9			69.9	69.9
Actuated g/C Ratio				0.11		0.11		0.78			0.78	0.78
Clearance Time (s)				5.0		5.0		5.0			5.0	5.0
Vehicle Extension (s)				3.0		3.0		3.0			3.0	3.0
Lane Grp Cap (vph)				188		144		1386			1295	1120
v/s Ratio Prot				0.03							c0.45	
v/s Ratio Perm						c0.03		0.18				0.03
v/c Ratio				0.23		0.24		0.23			0.58	0.04
Uniform Delay, d1				36.4		36.5		2.7			4.1	2.3
Progression Factor				1.00		1.00		0.60			1.19	0.80
Incremental Delay, d2				0.6		0.9		0.3			1.8	0.1
Delay (s)				37.0		37.3		2.0			6.6	1.9
Level of Service				D		D		A			A	A
Approach Delay (s)		0.0			37.3			2.0			6.3	
Approach LOS		A			D			A			A	

Intersection Summary			
HCM Average Control Delay	12.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	47.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

22: I-35 NB Ramps & Gardner Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	120	0	20	0	0	0	0	180	210	610	140	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0	5.0		5.0	
Lane Util. Factor		1.00						1.00	1.00		1.00	
Frt		0.98						1.00	0.85		1.00	
Flt Protected		0.96						1.00	1.00		0.96	
Satd. Flow (prot)		1716						1827	1599		1599	
Flt Permitted		0.96						1.00	1.00		0.64	
Satd. Flow (perm)		1716						1827	1599		1063	
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	132	0	22	0	0	0	0	198	231	670	154	0
RTOR Reduction (vph)	0	6	0	0	0	0	0	0	44	0	0	0
Lane Group Flow (vph)	0	148	0	0	0	0	0	198	187	0	824	0
Heavy Vehicles (%)	4%	0%	5%	0%	0%	0%	0%	4%	1%	17%	2%	0%
Turn Type	Perm								Perm	Perm		
Protected Phases		4						2			6	
Permitted Phases	4								2	6		
Actuated Green, G (s)		7.0						73.0	73.0		73.0	
Effective Green, g (s)		7.0						73.0	73.0		73.0	
Actuated g/C Ratio		0.08						0.81	0.81		0.81	
Clearance Time (s)		5.0						5.0	5.0		5.0	
Vehicle Extension (s)		3.0						3.0	3.0		3.0	
Lane Grp Cap (vph)		133						1482	1297		862	
v/s Ratio Prot								0.11				
v/s Ratio Perm		0.09							0.12		c0.78	
v/c Ratio		1.11						0.13	0.14		0.96	
Uniform Delay, d1		41.5						1.8	1.8		7.1	
Progression Factor		1.00						1.00	1.00		1.67	
Incremental Delay, d2		110.4						0.2	0.2		19.6	
Delay (s)		151.9						2.0	2.1		31.5	
Level of Service		F						A	A		C	
Approach Delay (s)		151.9			0.0			2.0			31.5	
Approach LOS		F			A			A			C	

Intersection Summary			
HCM Average Control Delay	35.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	74.5%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

23: E 191st Street & Gardner Rd

AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	10	380	0	5	150
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	11	409	0	5	161
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						220
pX, platoon unblocked						
vC, conflicting volume	581	409			409	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	581	409			409	
tC, single (s)	6.4	6.2			4.3	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.4	
p0 queue free %	100	98			99	
cM capacity (veh/h)	477	647			1060	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	11	409	167
Volume Left	0	0	5
Volume Right	11	0	0
cSH	647	1700	1060
Volume to Capacity	0.02	0.24	0.01
Queue Length 95th (ft)	1	0	0
Control Delay (s)	10.7	0.0	0.3
Lane LOS	B		A
Approach Delay (s)	10.7	0.0	0.3
Approach LOS	B		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	30.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

24: Sunflower Road & US 56

AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	10	40	0	0	10	390	70	5	110	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	6	13	51	0	0	13	494	89	6	139	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	715	759	139	731	715	538	139			582		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	715	759	139	731	715	538	139			582		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	84	100	100	99			99		
cM capacity (veh/h)	344	333	914	317	353	547	1457			1002		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	25	51	595	146
Volume Left	6	51	13	6
Volume Right	13	0	89	0
cSH	494	317	1457	1002
Volume to Capacity	0.05	0.16	0.01	0.01
Queue Length 95th (ft)	4	14	1	0
Control Delay (s)	12.7	18.5	0.3	0.4
Lane LOS	B	C	A	A
Approach Delay (s)	12.7	18.5	0.3	0.4
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	42.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

25: US 56 & 4th Street

AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	410	60	20	130	20	50
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	526	77	26	167	26	64
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			603		782	564
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			603		782	564
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		93	88
cM capacity (veh/h)			960		349	525

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	603	192	90
Volume Left	0	26	26
Volume Right	77	0	64
cSH	1700	960	459
Volume to Capacity	0.35	0.03	0.20
Queue Length 95th (ft)	0	2	18
Control Delay (s)	0.0	1.4	14.7
Lane LOS		A	B
Approach Delay (s)	0.0	1.4	14.7
Approach LOS			B

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	36.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

26: 199th Street & Four Corners Road

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	70	30	20	10	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	12	83	36	24	12	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	60				155	48
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	60				155	48
tC, single (s)	4.3				6.6	6.6
tC, 2 stage (s)						
tF (s)	2.4				3.7	3.7
p0 queue free %	99				98	99
cM capacity (veh/h)	1437				790	923

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	95	60	18
Volume Left	12	0	12
Volume Right	0	24	6
cSH	1437	1700	830
Volume to Capacity	0.01	0.04	0.02
Queue Length 95th (ft)	1	0	2
Control Delay (s)	1.0	0.0	9.4
Lane LOS	A		A
Approach Delay (s)	1.0	0.0	9.4
Approach LOS			A

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	20.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

27: 199th Street & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	70	30	10	5	30	70	10	270	10	40	70	40
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	79	34	11	6	34	79	11	303	11	45	79	45

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	124	118	326	169
Volume Left (vph)	79	6	11	45
Volume Right (vph)	11	79	11	45
Hadj (s)	0.13	-0.34	0.03	-0.07
Departure Headway (s)	5.4	5.0	4.8	4.9
Degree Utilization, x	0.19	0.16	0.44	0.23
Capacity (veh/h)	597	643	716	680
Control Delay (s)	9.7	9.0	11.5	9.4
Approach Delay (s)	9.7	9.0	11.5	9.4
Approach LOS	A	A	B	A

Intersection Summary			
Delay	10.3		
HCM Level of Service	B		
Intersection Capacity Utilization	45.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

30: US-56 & I-35 NB Loop

AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	410	1650	0	600	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	461	1854	0	674	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked						
vC, conflicting volume			2315		798	230
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			2315		798	230
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			219		328	778

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	230	230	1854	337	337
Volume Left	0	0	0	0	0
Volume Right	0	0	1854	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.14	0.14	1.09	0.20	0.20
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	105.5%	ICU Level of Service	G
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

80: 191st Street & Driveway A

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	10	5	70	95	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	11	5	76	103	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	82				65	43
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	82				65	43
tC, single (s)	5.1				7.4	7.2
tC, 2 stage (s)						
tF (s)	3.1				4.4	4.2
p0 queue free %	99				86	99
cM capacity (veh/h)	1071				741	806

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	16	82	103	5
Volume Left	5	0	103	0
Volume Right	0	76	0	5
cSH	1071	1700	741	806
Volume to Capacity	0.01	0.05	0.14	0.01
Queue Length 95th (ft)	0	0	12	1
Control Delay (s)	2.8	0.0	10.6	9.5
Lane LOS	A		B	A
Approach Delay (s)	2.8	0.0	10.6	
Approach LOS			B	

Intersection Summary			
Average Delay	5.8		
Intersection Capacity Utilization	16.9%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Gardner IMF Operations + Induced Development - (Mitigated) - AM Peak Hour - Synchro Intersection LOS

81: 191st Street & Driveway B

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	120	90	180	30	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	130	98	196	33	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	293				348	196
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	293				348	196
tC, single (s)	4.5				6.8	7.0
tC, 2 stage (s)						
tF (s)	2.6				3.8	4.0
p0 queue free %	99				94	99
cM capacity (veh/h)	1080				578	681

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	141	293	33	5
Volume Left	11	0	33	0
Volume Right	0	196	0	5
cSH	1080	1700	578	681
Volume to Capacity	0.01	0.17	0.06	0.01
Queue Length 95th (ft)	1	0	4	1
Control Delay (s)	0.7	0.0	11.6	10.3
Lane LOS	A		B	B
Approach Delay (s)	0.7	0.0	11.4	
Approach LOS			B	

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	25.8%	ICU Level of Service	A
Analysis Period (min)	15		

82: Driveway C & Waverly Road

AM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	30	30	30	30	70	30
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	33	33	33	33	76	33
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	190	92	109			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	190	92	109			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	96	97	98			
cM capacity (veh/h)	786	970	1494			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	33	33	65	109
Volume Left	33	0	33	0
Volume Right	0	33	0	33
cSH	786	970	1494	1700
Volume to Capacity	0.04	0.03	0.02	0.06
Queue Length 95th (ft)	3	3	2	0
Control Delay (s)	9.8	8.8	3.8	0.0
Lane LOS	A	A	A	
Approach Delay (s)	9.3		3.8	0.0
Approach LOS	A			

Intersection Summary			
Average Delay	3.6		
Intersection Capacity Utilization	19.9%	ICU Level of Service	A
Analysis Period (min)	15		

83: Driveway D & Waverly Road

AM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	30	20	90	40	70	170
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	33	22	98	43	76	185
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	408	168	261			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	408	168	261			
tC, single (s)	6.8	6.7	4.2			
tC, 2 stage (s)						
tF (s)	3.9	3.8	2.3			
p0 queue free %	93	97	92			
cM capacity (veh/h)	492	765	1258			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	33	22	141	261
Volume Left	33	0	98	0
Volume Right	0	22	0	185
cSH	492	765	1258	1700
Volume to Capacity	0.07	0.03	0.08	0.15
Queue Length 95th (ft)	5	2	6	0
Control Delay (s)	12.8	9.8	5.8	0.0
Lane LOS	B	A	A	
Approach Delay (s)	11.6		5.8	0.0
Approach LOS	B			

Intersection Summary			
Average Delay	3.2		
Intersection Capacity Utilization	34.6%	ICU Level of Service	A
Analysis Period (min)	15		

84: 191st Street & Driveway E

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	105	70	20	20	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	114	76	22	22	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	98				212	87
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	98				212	87
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				97	99
cM capacity (veh/h)	1508				778	977

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	120	98	27
Volume Left	5	0	22
Volume Right	0	22	5
cSH	1508	1700	811
Volume to Capacity	0.00	0.06	0.03
Queue Length 95th (ft)	0	0	3
Control Delay (s)	0.4	0.0	9.6
Lane LOS	A		A
Approach Delay (s)	0.4	0.0	9.6
Approach LOS			A

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	19.6%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Gardner IMF Operations + Induced Development - (Mitigated) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
1: 175th Street & Waverly Road
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱			↰↑↱			↰↑↱			↰↑↱	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	100	10	5	320	90	20	40	5	40	40	20
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	24	120	12	6	386	108	24	48	6	48	48	24

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	157	500	78	120
Volume Left (vph)	24	6	24	48
Volume Right (vph)	12	108	6	24
Hadj (s)	0.06	-0.07	0.04	-0.02
Departure Headway (s)	5.2	4.6	5.8	5.6
Degree Utilization, x	0.23	0.64	0.13	0.19
Capacity (veh/h)	643	754	538	566
Control Delay (s)	9.7	15.7	9.6	9.9
Approach Delay (s)	9.7	15.7	9.6	9.9
Approach LOS	A	C	A	A

Intersection Summary			
Delay	13.2		
HCM Level of Service	B		
Intersection Capacity Utilization	37.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
2: US 56 & Gardner Road
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↑↱			↰↑↑↱		↰	↑↱		↰	↑↱	
Volume (vph)	50	420	60	250	820	250	70	170	160	160	170	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.98			0.97		1.00	0.93		1.00	0.96	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3284			3358		1787	1694		1736	1752	
Flt Permitted		0.64			0.69		0.45	1.00		0.30	1.00	
Satd. Flow (perm)		2121			2335		846	1694		541	1752	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	57	483	69	287	943	287	80	195	184	184	195	80
RTOR Reduction (vph)	0	10	0	0	20	0	0	34	0	0	15	0
Lane Group Flow (vph)	0	599	0	0	1497	0	80	345	0	184	260	0
Heavy Vehicles (%)	2%	9%	2%	1%	5%	1%	1%	4%	4%	4%	4%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		59.1			59.1		29.2	29.2		29.2	29.2	
Effective Green, g (s)		59.1			59.1		29.2	29.2		29.2	29.2	
Actuated g/C Ratio		0.59			0.59		0.29	0.29		0.29	0.29	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1254			1380		247	495		158	512	
v/s Ratio Prot								0.20			0.15	
v/s Ratio Perm		0.28			c0.64		0.09			c0.34		
v/c Ratio		0.48			1.08		0.32	0.70		1.16	0.51	
Uniform Delay, d1		11.7			20.5		27.7	31.5		35.4	29.4	
Progression Factor		1.00			0.47		1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.3			49.2		0.8	4.3		122.7	0.8	
Delay (s)		13.0			58.8		28.4	35.7		158.1	30.2	
Level of Service		B			E		C	D		F	C	
Approach Delay (s)		13.0			58.8			34.5			81.5	
Approach LOS		B			E			C			F	

Intersection Summary			
HCM Average Control Delay	49.4	HCM Level of Service	D
HCM Volume to Capacity ratio	1.11		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	11.7
Intersection Capacity Utilization	100.0%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
3: US 56 & Elm
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↑↱			↰↑↑↱			↰↑↱			↰↑↱	
Volume (vph)	10	760	20	40	1290	40	20	10	50	70	10	30
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			1.00			0.92			0.96	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3577			3671			1765			1856	
Flt Permitted		0.93			0.90			0.92			0.72	
Satd. Flow (perm)		3324			3304			1638			1373	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	11	817	22	43	1387	43	22	11	54	75	11	32
RTOR Reduction (vph)	0	1	0	0	1	0	0	47	0	0	16	0
Lane Group Flow (vph)	0	849	0	0	1472	0	0	40	0	0	102	0
Heavy Vehicles (%)	0%	6%	0%	3%	3%	0%	5%	0%	2%	1%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		78.3			78.3			12.7			12.7	
Effective Green, g (s)		78.3			78.3			12.7			12.7	
Actuated g/C Ratio		0.78			0.78			0.13			0.13	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2603			2587			208			174	
v/s Ratio Prot												
v/s Ratio Perm		0.26			c0.45			0.02			c0.07	
v/c Ratio		0.33			0.57			0.19			0.59	
Uniform Delay, d1		3.2			4.2			39.1			41.2	
Progression Factor		0.60			0.22			1.00			1.00	
Incremental Delay, d2		0.2			0.2			0.5			5.0	
Delay (s)		2.1			1.2			39.5			46.2	
Level of Service		A			A			D			D	
Approach Delay (s)		2.1			1.2			39.5			46.2	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	4.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	82.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
4: US 56 & Mulberry
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↑↱			↰↑↑↱			↰↑↱			↰↑↱	
Volume (vph)	10	870	10	30	1380	40	10	5	20	40	10	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			4.0			4.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frt		1.00			1.00			0.92			0.96	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3402			3492			1678			1776	
Flt Permitted		0.93			0.91			0.92			0.87	
Satd. Flow (perm)		3164			3197			1567			1583	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	11	935	11	32	1484	43	11	5	22	43	11	22
RTOR Reduction (vph)	0	1	0	0	2	0	0	20	0	0	16	0
Lane Group Flow (vph)	0	956	0	0	1557	0	0	18	0	0	60	0
Heavy Vehicles (%)	0%	6%	0%	0%	3%	0%	0%	0%	5%	0%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		83.0			83.0			8.0			8.0	
Effective Green, g (s)		83.0			83.0			8.0			8.0	
Actuated g/C Ratio		0.83			0.83			0.08			0.08	
Clearance Time (s)		5.0			5.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		2626			2654			125			127	
v/s Ratio Prot												
v/s Ratio Perm		0.30			c0.49			0.01			c0.04	
v/c Ratio		0.36			0.59			0.14			0.48	
Uniform Delay, d1		2.1			2.8			42.8			44.0	
Progression Factor		0.98			0.81			1.00			1.00	
Incremental Delay, d2		0.4			0.2			0.5			2.8	
Delay (s)		2.4			2.5			43.3			46.8	
Level of Service		A			A			D			D	
Approach Delay (s)		2.4			2.5			43.3			46.8	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	4.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	75.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

2015 Gardner IMF Operations + Induced Development - (Mitigated) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
5: US 56 & Moonlight Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	140	560	250	190	1160	600	150	190	60	280	240	110
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1736	3551	1583	1770	3505	1583	1770	3539	1583	3433	3539	1553
Flt Permitted	0.11	1.00	1.00	0.37	1.00	1.00	0.59	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	206	3551	1583	687	3505	1583	1097	3539	1583	3433	3539	1553
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	154	615	275	209	1275	659	165	209	66	308	264	121
RTOR Reduction (vph)	0	0	143	0	0	250	0	0	60	0	0	108
Lane Group Flow (vph)	154	615	132	209	1275	409	165	209	6	308	264	13
Heavy Vehicles (%)	4%	7%	2%	2%	3%	2%	2%	2%	2%	2%	2%	4%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	Prot		Perm
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6	8		8			4
Actuated Green, G (s)	55.9	47.9	47.9	57.7	48.8	48.8	17.5	8.4	8.4	11.8	11.1	11.1
Effective Green, g (s)	55.9	47.9	47.9	57.7	48.8	48.8	17.5	8.4	8.4	11.8	11.1	11.1
Actuated g/C Ratio	0.56	0.48	0.48	0.58	0.49	0.49	0.18	0.08	0.08	0.12	0.11	0.11
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	238	1701	758	493	1710	773	253	297	133	405	393	172
v/s Ratio Prot	c0.05	0.17		0.04	c0.36		0.06	0.06		c0.09	c0.07	
v/s Ratio Perm	0.31		0.08	0.21		0.26	0.05		0.00			0.01
v/c Ratio	0.65	0.36	0.17	0.42	0.75	0.53	0.65	0.70	0.04	0.76	0.67	0.08
Uniform Delay, d1	15.0	16.4	14.8	10.4	20.6	17.7	37.5	44.6	42.1	42.7	42.7	39.9
Progression Factor	1.35	0.76	0.83	0.67	0.82	0.80	0.93	0.94	0.79	1.00	1.00	1.00
Incremental Delay, d2	4.3	0.6	0.5	0.2	2.4	2.0	4.5	6.0	0.0	7.4	3.5	0.1
Delay (s)	24.6	13.0	12.7	7.2	19.2	16.1	39.3	48.0	33.4	50.1	46.2	39.9
Level of Service	C	B	B	A	B	B	D	D	C	D	D	D
Approach Delay (s)		14.6			17.1			42.5			46.9	
Approach LOS		B			B			D			D	

Intersection Summary			
HCM Average Control Delay	23.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	16.5
Intersection Capacity Utilization	74.0%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
6: Old US 56 & US 56 — PM Peak Hour

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	130	20	780	120	10	1830
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	4.0	6.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1736	1538	3619	1568	1805	3689
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1736	1538	3619	1568	1805	3689
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	134	21	804	124	10	1887
RTOR Reduction (vph)	0	18	0	66	0	0
Lane Group Flow (vph)	134	3	804	58	10	1887
Heavy Vehicles (%)	4%	5%	5%	3%	0%	3%
Turn Type		Perm		custom	Prot	
Protected Phases	8		2	4	1	6
Permitted Phases		8				
Actuated Green, G (s)	12.8	12.8	71.7	12.8	1.5	76.2
Effective Green, g (s)	12.8	12.8	71.7	12.8	1.5	76.2
Actuated g/C Ratio	0.13	0.13	0.72	0.13	0.02	0.76
Clearance Time (s)	5.0	5.0	5.0	5.0	4.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	222	197	2595	201	27	2811
v/s Ratio Prot	c0.08		0.22	0.04	0.01	c0.51
v/s Ratio Perm		0.00				
v/c Ratio	0.60	0.01	0.31	0.29	0.37	0.67
Uniform Delay, d1	41.2	38.1	5.1	39.5	48.8	5.8
Progression Factor	1.00	1.00	1.28	1.17	1.00	1.00
Incremental Delay, d2	4.6	0.0	0.3	0.7	8.4	1.3
Delay (s)	45.8	38.1	6.9	46.8	57.2	7.1
Level of Service	D	D	A	D	E	A
Approach Delay (s)	44.7		12.2			7.4
Approach LOS	D		B			A

Intersection Summary			
HCM Average Control Delay	10.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	11.0
Intersection Capacity Utilization	64.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
7: US-56 & Cedar Niles — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	1410	180	520	1430	40	140	20	400	40	10	30
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2	5.2	5.2	5.2	
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00		1.00	0.88	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85	1.00	0.89	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1805	3689	1599	3502	3654	1615		1820	2842	1805	1685	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.72	1.00	0.43	1.00	
Satd. Flow (perm)	1805	3689	1599	3502	3654	1615		1368	2842	809	1685	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	45	1584	202	584	1607	45	157	22	449	45	11	34
RTOR Reduction (vph)	0	0	94	0	0	15	0	0	0	0	29	0
Lane Group Flow (vph)	45	1584	108	584	1607	30	0	179	449	45	16	0
Heavy Vehicles (%)	0%	3%	1%	0%	4%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Prot		Perm	Prot		Perm	Perm		pt+ov	Perm		
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases			2			6	8			4		
Actuated Green, G (s)	6.4	63.9	63.9	22.6	80.1	80.1		17.9	44.5	17.9	17.9	
Effective Green, g (s)	6.4	63.9	63.9	22.6	80.1	80.1		17.9	40.5	17.9	17.9	
Actuated g/C Ratio	0.05	0.53	0.53	0.19	0.67	0.67		0.15	0.34	0.15	0.15	
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4		5.2		5.2	5.2	
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0		1.0		1.0	1.0	
Lane Grp Cap (vph)	96	1964	851	660	2439	1078		204	959	121	251	
v/s Ratio Prot	0.02	c0.43		c0.17	0.44				0.16		0.01	
v/s Ratio Perm			0.07			0.02		c0.13		0.06		
v/c Ratio	0.47	0.81	0.13	0.88	0.66	0.03		0.88	0.47	0.37	0.06	
Uniform Delay, d1	55.1	23.0	14.1	47.4	11.8	6.8		50.0	31.3	46.0	43.9	
Progression Factor	1.00	1.00	1.00	0.80	0.47	0.19		1.00	1.00	1.00	1.00	
Incremental Delay, d2	1.3	3.7	0.3	7.0	0.7	0.0		31.0	0.1	0.7	0.0	
Delay (s)	56.5	26.7	14.4	45.1	6.2	1.3		81.0	31.4	46.7	43.9	
Level of Service	E	C	B	D	A	A		F	C	D	D	
Approach Delay (s)		26.0			16.3			45.5			45.3	
Approach LOS		C			B			D			D	

Intersection Summary			
HCM Average Control Delay	24.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.6
Intersection Capacity Utilization	80.3%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
8: US-56 & I-35 SB Ramps — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1610	240	130	540	0	0	0	0	140	0	1450
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		0.98		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3437		1687	3725					1787		2760
Flt Permitted		1.00		0.95	1.00					0.95		1.00
Satd. Flow (perm)		3437		1687	3725					1787		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1695	253	137	568	0	0	0	0	147	0	1526
RTOR Reduction (vph)	0	10	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	1938	0	137	568	0	0	0	0	147	0	1526
Heavy Vehicles (%)	0%	3%	3%	7%	2%	0%	0%	0%	0%	1%	0%	3%
Turn Type				Prot						Prot		custom
Protected Phases		2		1	6					7		5
Permitted Phases												4
Actuated Green, G (s)		77.3		14.7	27.1					13.0		64.9
Effective Green, g (s)		77.3		14.7	27.1					13.0		64.9
Actuated g/C Ratio		0.64		0.12	0.23					0.11		0.54
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2214		207	841					194		1493
v/s Ratio Prot		c0.56		0.08	c0.15					c0.08		c0.55
v/s Ratio Perm												
v/c Ratio		0.88		0.66	0.68					0.76		1.02
Uniform Delay, d1		17.4		50.3	42.4					52.0		27.6
Progression Factor		0.59		0.96	0.96					1.00		1.00
Incremental Delay, d2		3.7		7.0	3.9					15.5		29.0
Delay (s)		14.0		55.3	44.5					67.5		56.6
Level of Service		B		E	D					E		E
Approach Delay (s)		14.0			46.6			0.0			57.5	
Approach LOS		B			D			A			E	

Intersection Summary			
HCM Average Control Delay	36.2	HCM Level of Service	D
HCM Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	78.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

9: US-56 & I-35 NB Ramps — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	540	0	0	580	20	90	0	60	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			1.00			0.95				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3762			1832			1595				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3762			1832			1595				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	614	0	0	659	23	102	0	68	0	0	0
RTOR Reduction (vph)	0	0	0	0	1	0	0	22	0	0	0	0
Lane Group Flow (vph)	0	614	0	0	681	0	0	148	0	0	0	0
Heavy Vehicles (%)	0%	1%	0%	0%	3%	10%	7%	0%	13%	0%	0%	0%
Turn Type				Perm			Perm					
Protected Phases		2			6			8				
Permitted Phases				6			8					
Actuated Green, G (s)		93.7			93.7			16.3				
Effective Green, g (s)		93.7			93.7			16.3				
Actuated g/C Ratio		0.78			0.78			0.14				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		2937			1430			217				
v/s Ratio Prot		0.16			c0.37							
v/s Ratio Perm								0.09				
v/c Ratio		0.21			0.48			0.68				
Uniform Delay, d1		3.4			4.6			49.4				
Progression Factor		1.22			1.00			1.00				
Incremental Delay, d2		0.1			1.1			8.2				
Delay (s)		4.3			5.7			57.6				
Level of Service		A			A			E				
Approach Delay (s)		4.3			5.7			57.6			0.0	
Approach LOS		A			A			E			A	

Intersection Summary			
HCM Average Control Delay	11.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	77.6%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

10: Sante Fe & Moonlight — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	110	130	270	70	160	530
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.97		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3457		1770	3539
Flt Permitted	0.95	1.00	1.00		0.53	1.00
Satd. Flow (perm)	1770	1583	3457		995	3539
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	118	140	290	75	172	570
RTOR Reduction (vph)	0	123	13	0	0	0
Lane Group Flow (vph)	118	17	352	0	172	570
Heavy Vehicles (%)	2%	2%	1%	2%	2%	2%
Turn Type		Perm			Perm	
Protected Phases	6		8			4
Permitted Phases		6			4	
Actuated Green, G (s)	12.0	12.0	78.0		78.0	78.0
Effective Green, g (s)	12.0	12.0	78.0		78.0	78.0
Actuated g/C Ratio	0.12	0.12	0.78		0.78	0.78
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	212	190	2696		776	2760
v/s Ratio Prot	c0.07		0.10			0.16
v/s Ratio Perm		0.01			c0.17	
v/c Ratio	0.56	0.09	0.13		0.22	0.21
Uniform Delay, d1	41.5	39.1	2.7		2.9	2.9
Progression Factor	1.00	1.00	1.00		0.55	0.55
Incremental Delay, d2	3.1	0.2	0.1		0.6	0.2
Delay (s)	44.6	39.3	2.8		2.2	1.7
Level of Service	D	D	A		A	A
Approach Delay (s)	41.8		2.8			1.8
Approach LOS	D		A			A

Intersection Summary			
HCM Average Control Delay	9.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.27		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	37.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

11: Waverly Road & US 56 — PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	5	40	160	10	30	20	20	140	5	130	300	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.89			0.96			1.00			1.00	
Flt Protected		1.00			0.99			0.99			0.99	
Satd. Flow (prot)		1578			1717			1734			1737	
Flt Permitted		0.99			0.93			0.92			0.83	
Satd. Flow (perm)		1566			1606			1606			1470	
Peak-hour factor, PHF	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Adj. Flow (vph)	6	51	203	13	38	25	25	177	6	165	380	6
RTOR Reduction (vph)	0	150	0	0	20	0	0	1	0	0	0	0
Lane Group Flow (vph)	0	110	0	0	56	0	0	207	0	0	551	0
Heavy Vehicles (%)	0%	3%	9%	10%	3%	5%	0%	10%	0%	14%	5%	0%
Bus Blockages (#/hr)	1	0	0	0	0	0	0	0	0	0	0	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2	2		6		
Actuated Green, G (s)		8.5			8.5			22.4			22.4	
Effective Green, g (s)		8.5			8.5			22.4			22.4	
Actuated g/C Ratio		0.21			0.21			0.55			0.55	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		325			334			880			805	
v/s Ratio Prot												
v/s Ratio Perm		c0.07			0.03			0.13			c0.37	
v/c Ratio		0.34			0.17			0.23			0.68	
Uniform Delay, d1		13.8			13.3			4.8			6.7	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.6			0.2			0.1			2.4	
Delay (s)		14.4			13.5			4.9			9.1	
Level of Service		B			B			A			A	
Approach Delay (s)		14.4			13.5			4.9			9.1	
Approach LOS		B			B			A			A	

Intersection Summary			
HCM Average Control Delay	9.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	40.9	Sum of lost time (s)	10.0
Intersection Capacity Utilization	57.3%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

12: 183rd Street & Four Corners Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	10	5	0	10	10	5	5	0	5	5	5
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	11	5	0	11	11	5	5	0	5	5	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	22	22	11	16
Volume Left (vph)	5	0	5	5
Volume Right (vph)	5	11	0	5
Hadj (s)	-0.10	-0.30	0.10	-0.13
Departure Headway (s)	3.9	3.7	4.1	3.9
Degree Utilization, x	0.02	0.02	0.01	0.02
Capacity (veh/h)	915	965	855	916
Control Delay (s)	7.0	6.8	7.2	6.9
Approach Delay (s)	7.0	6.8	7.2	6.9
Approach LOS	A	A	A	A

Intersection Summary			
Delay	6.9		
HCM Level of Service	A		
Intersection Capacity Utilization	15.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
13: 183rd Street & US 56 — PM Peak Hour

Intersection Sign configuration not allowed in HCM analysis.

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
14: 183rd Street & Waverly Road — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	10	70	60	10	60	50
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	76	65	11	65	54
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	255	71			76	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	255	71			76	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	98	92			96	
cM capacity (veh/h)	706	998			1536	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	87	76	120
Volume Left	11	0	65
Volume Right	76	11	0
cSH	949	1700	1536
Volume to Capacity	0.09	0.04	0.04
Queue Length 95th (ft)	8	0	3
Control Delay (s)	9.2	0.0	4.2
Lane LOS	A		A
Approach Delay (s)	9.2	0.0	4.2
Approach LOS	A		

Intersection Summary			
Average Delay	4.6		
Intersection Capacity Utilization	24.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
15: 183rd Street & Gardner Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	40	80	60	50	50	120	310	130	70	280	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	2.5	2.5		2.5	2.5		2.5	2.5		2.5	2.5	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.90		1.00	0.92		1.00	0.96		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1752	1699		1770	1723		1787	3314		1787	3402	
Flt Permitted	0.56	1.00		0.50	1.00		0.50	1.00		0.45	1.00	
Satd. Flow (perm)	1038	1699		925	1723		950	3314		852	3402	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	45	45	90	67	56	56	135	348	146	79	315	56
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	45	135	0	67	112	0	135	494	0	79	371	0
Heavy Vehicles (%)	3%	0%	1%	2%	2%	2%	1%	5%	2%	1%	4%	2%
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	14.0	9.9		15.6	10.7		51.1	44.7		49.3	43.8	
Effective Green, g (s)	14.0	9.9		15.6	10.7		51.1	44.7		49.3	43.8	
Actuated g/C Ratio	0.19	0.13		0.21	0.14		0.68	0.60		0.66	0.58	
Clearance Time (s)	2.5	2.5		2.5	2.5		2.5	2.5		2.5	2.5	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	233	224		248	246		719	1975		629	1987	
v/s Ratio Prot	0.01	c0.08		c0.02	0.07		c0.02	c0.15		0.01	0.11	
v/s Ratio Perm	0.03			0.04			0.11			0.07		
v/c Ratio	0.19	0.60		0.27	0.46		0.19	0.25		0.13	0.19	
Uniform Delay, d1	27.2	30.7		27.2	29.5		4.2	7.2		4.6	7.3	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.4	4.5		0.6	1.3		0.1	0.3		0.1	0.0	
Delay (s)	27.6	35.2		27.8	30.8		4.3	7.5		4.7	7.3	
Level of Service	C	D		C	C		A	A		A	A	
Approach Delay (s)		33.3			29.7			6.8			6.9	
Approach LOS		C			C			A			A	

Intersection Summary			
HCM Average Control Delay	13.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.30		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	36.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
16: Four Corners Road & US 56 — PM Peak Hour

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	0	5	5	180	330	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	0	7	7	237	434	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	684	434	434			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	684	434	434			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	99	99			
cM capacity (veh/h)	415	626	1136			

Direction, Lane #	SB 1	NE 1	SW 1
Volume Total	7	243	434
Volume Left	0	7	0
Volume Right	7	0	0
cSH	626	1136	1700
Volume to Capacity	0.01	0.01	0.26
Queue Length 95th (ft)	1	0	0
Control Delay (s)	10.8	0.3	0.0
Lane LOS	B	A	
Approach Delay (s)	10.8	0.3	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.2		
Intersection Capacity Utilization	27.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

17: 191st Street & US 56

PM Peak Hour

Intersection Sign configuration not allowed in HCM analysis.

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

19: 191st Street & Waverly Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	50	200	0	5	210	20	5	5	5	20	5	40
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	54	217	0	5	228	22	5	5	5	22	5	43
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	250			217			622	587	217	584	576	239
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	250			217			622	587	217	584	576	239
tC, single (s)	4.3			4.1			7.1	6.5	6.2	7.3	6.5	6.5
tC, 2 stage (s)												
tF (s)	2.4			2.2			3.5	4.0	3.3	3.7	4.0	3.6
p0 queue free %	95			100			98	99	99	94	99	94
cM capacity (veh/h)	1207			1364			360	404	827	376	410	740

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	272	255	16	71
Volume Left	54	5	5	22
Volume Right	0	22	5	43
cSH	1207	1364	464	544
Volume to Capacity	0.05	0.00	0.04	0.13
Queue Length 95th (ft)	4	0	3	11
Control Delay (s)	2.0	0.2	13.0	12.6
Lane LOS	A	A	B	B
Approach Delay (s)	2.0	0.2	13.0	12.6
Approach LOS			B	B

Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	40.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

20: W 188th Street & Gardner Rd

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	10	220	20	10	20	220	610	20	20	480	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00			0.95			0.95	1.00
Frt	1.00	1.00	0.85		0.95			1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00		0.98			0.99			1.00	1.00
Satd. Flow (prot)	1805	1900	1137		1762			3052			3502	1538
Flt Permitted	0.85	1.00	1.00		0.87			0.69			0.90	1.00
Satd. Flow (perm)	1616	1900	1137		1565			2125			3168	1538
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	21	11	232	22	11	22	232	642	22	22	505	21
RTOR Reduction (vph)	0	0	207	0	20	0	0	1	0	0	0	5
Lane Group Flow (vph)	21	11	25	0	35	0	0	895	0	0	527	16
Heavy Vehicles (%)	0%	0%	42%	0%	0%	0%	52%	4%	0%	0%	3%	5%
Turn Type	Perm		Perm	Perm			Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	9.8	9.8	9.8		9.8			70.2			70.2	70.2
Effective Green, g (s)	9.8	9.8	9.8		9.8			70.2			70.2	70.2
Actuated g/C Ratio	0.11	0.11	0.11		0.11			0.78			0.78	0.78
Clearance Time (s)	5.0	5.0	5.0		5.0			5.0			5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	176	207	124		170			1658			2471	1200
v/s Ratio Prot		0.01										
v/s Ratio Perm	0.01		0.02		c0.02			c0.42			0.17	0.01
v/c Ratio	0.12	0.05	0.20		0.21			0.54			0.21	0.01
Uniform Delay, d1	36.2	35.9	36.5		36.6			3.8			2.6	2.2
Progression Factor	1.00	1.00	1.00		1.00			1.19			1.00	1.00
Incremental Delay, d2	0.3	0.1	0.8		0.6			1.0			0.2	0.0
Delay (s)	36.5	36.0	37.4		37.2			5.5			2.8	2.2
Level of Service	D	D	D		D			A			A	A
Approach Delay (s)		37.2			37.2			5.5			2.8	
Approach LOS		D			D			A			A	

Intersection Summary			
HCM Average Control Delay	10.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	59.8%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

21: I-35 SB Ramps & Gardner Rd

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	170	0	640	10	210	0	0	600	120
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0		5.0		5.0			5.0	5.0
Lane Util. Factor				1.00		1.00		1.00			1.00	1.00
Frt				1.00		0.85		1.00			1.00	0.85
Flt Protected				0.95		1.00		1.00			1.00	1.00
Satd. Flow (prot)				1736		1346		1785			1638	1495
Flt Permitted				0.95		1.00		0.97			1.00	1.00
Satd. Flow (perm)				1736		1346		1738			1638	1495
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	181	0	681	11	223	0	0	638	128
RTOR Reduction (vph)	0	0	0	0	0	497	0	0	0	0	0	42
Lane Group Flow (vph)	0	0	0	181	0	184	0	234	0	0	638	86
Heavy Vehicles (%)	0%	0%	0%	4%	0%	20%	10%	6%	0%	0%	16%	8%
Turn Type				Prot		custom	Perm					Perm
Protected Phases				3				2			6	
Permitted Phases						3	2					6
Actuated Green, G (s)				19.2		19.2		60.8			60.8	60.8
Effective Green, g (s)				19.2		19.2		60.8			60.8	60.8
Actuated g/C Ratio				0.21		0.21		0.68			0.68	0.68
Clearance Time (s)				5.0		5.0		5.0			5.0	5.0
Vehicle Extension (s)				3.0		3.0		3.0			3.0	3.0
Lane Grp Cap (vph)				370		287		1174			1107	1010
v/s Ratio Prot				0.10							c0.39	
v/s Ratio Perm						c0.14		0.13				0.06
v/c Ratio				0.49		0.64		0.20			0.58	0.09
Uniform Delay, d1				31.1		32.3		5.5			7.8	5.0
Progression Factor				1.00		1.00		0.73			1.27	2.29
Incremental Delay, d2				1.0		4.8		0.4			2.1	0.2
Delay (s)				32.1		37.1		4.3			12.0	11.7
Level of Service				C		D		A			B	B
Approach Delay (s)		0.0			36.0			4.3			11.9	
Approach LOS		A			D			A			B	

Intersection Summary			
HCM Average Control Delay	22.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	59.6%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

22: I-35 NB Ramps & Gardner Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	0	20	0	0	0	0	150	50	430	340	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0	5.0		5.0	
Lane Util. Factor		1.00						1.00	1.00		1.00	
Frt		0.97						1.00	0.85		1.00	
Flt Protected		0.96						1.00	1.00		0.97	
Satd. Flow (prot)		1595						1845	1553		1632	
Flt Permitted		0.96						1.00	1.00		0.74	
Satd. Flow (perm)		1595						1845	1553		1237	
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	77	0	22	0	0	0	0	165	55	473	374	0
RTOR Reduction (vph)	0	11	0	0	0	0	0	0	10	0	0	0
Lane Group Flow (vph)	0	88	0	0	0	0	0	165	45	0	847	0
Heavy Vehicles (%)	13%	0%	5%	0%	0%	0%	0%	3%	4%	23%	1%	0%
Turn Type	Perm								Perm	Perm		
Protected Phases		4						2			6	
Permitted Phases	4								2	6		
Actuated Green, G (s)		7.0						73.0	73.0		73.0	
Effective Green, g (s)		7.0						73.0	73.0		73.0	
Actuated g/C Ratio		0.08						0.81	0.81		0.81	
Clearance Time (s)		5.0						5.0	5.0		5.0	
Vehicle Extension (s)		3.0						3.0	3.0		3.0	
Lane Grp Cap (vph)		124						1497	1260		1003	
v/s Ratio Prot								0.09				
v/s Ratio Perm		0.06							0.03		c0.68	
v/c Ratio		0.71						0.11	0.04		0.84	
Uniform Delay, d1		40.5						1.8	1.7		5.1	
Progression Factor		1.00						1.00	1.00		1.41	
Incremental Delay, d2		16.9						0.1	0.1		7.7	
Delay (s)		57.4						1.9	1.7		14.9	
Level of Service		E						A	A		B	
Approach Delay (s)		57.4			0.0			1.9			14.9	
Approach LOS		E			A			A			B	

Intersection Summary			
HCM Average Control Delay	16.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	67.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

23: E 191st Street & Gardner Rd — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	5	200	5	10	350
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	5	215	5	11	376
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						220
pX, platoon unblocked						
vC, conflicting volume	616	218			220	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	616	218			220	
tC, single (s)	6.4	6.4			4.2	
tC, 2 stage (s)						
tF (s)	3.5	3.5			2.3	
p0 queue free %	100	99			99	
cM capacity (veh/h)	454	779			1303	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	5	220	387
Volume Left	0	0	11
Volume Right	5	5	0
cSH	779	1700	1303
Volume to Capacity	0.01	0.13	0.01
Queue Length 95th (ft)	1	0	1
Control Delay (s)	9.7	0.0	0.3
Lane LOS	A		A
Approach Delay (s)	9.7	0.0	0.3
Approach LOS	A		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	36.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

24: Sunflower Road & US 56 — PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	5	10	40	5	0	10	190	40	0	380	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	6	13	51	6	0	13	241	51	0	481	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	778	801	484	791	778	266	487			291		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	778	801	484	791	778	266	487			291		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	100	98	98	82	98	100	99			100		
cM capacity (veh/h)	308	316	587	287	326	778	1086			1282		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	19	57	304	487
Volume Left	0	51	13	0
Volume Right	13	0	51	6
cSH	457	291	1086	1282
Volume to Capacity	0.04	0.20	0.01	0.00
Queue Length 95th (ft)	3	18	1	0
Control Delay (s)	13.2	20.4	0.5	0.0
Lane LOS	B	C	A	
Approach Delay (s)	13.2	20.4	0.5	0.0
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	36.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)

25: US 56 & 4th Street — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	200	20	60	360	70	40
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	256	26	77	462	90	51
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			282		885	269
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			282		885	269
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			94		70	93
cM capacity (veh/h)			1292		298	774

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	282	538	141
Volume Left	0	77	90
Volume Right	26	0	51
cSH	1700	1292	384
Volume to Capacity	0.17	0.06	0.37
Queue Length 95th (ft)	0	5	41
Control Delay (s)	0.0	1.7	19.7
Lane LOS		A	C
Approach Delay (s)	0.0	1.7	19.7
Approach LOS			C

Intersection Summary			
Average Delay	3.8		
Intersection Capacity Utilization	50.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
26: 199th Street & Four Corners Road PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	40	50	5	10	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	12	48	60	6	12	12
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	65				134	62
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	65				134	62
tC, single (s)	4.4				6.6	6.4
tC, 2 stage (s)						
tF (s)	2.5				3.7	3.5
p0 queue free %	99				99	99
cM capacity (veh/h)	1376				812	954

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	60	65	24
Volume Left	12	0	12
Volume Right	0	6	12
cSH	1376	1700	877
Volume to Capacity	0.01	0.04	0.03
Queue Length 95th (ft)	1	0	2
Control Delay (s)	1.6	0.0	9.2
Lane LOS	A		A
Approach Delay (s)	1.6	0.0	9.2
Approach LOS			A

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	19.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
27: 199th Street & Gardner Road PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	20	20	10	40	60	10	100	10	60	200	50
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	22	22	22	11	45	67	11	112	11	67	225	56

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	67	124	135	348
Volume Left (vph)	22	11	11	67
Volume Right (vph)	22	67	11	56
Hadj (s)	-0.08	-0.23	0.02	-0.02
Departure Headway (s)	5.2	4.9	4.8	4.5
Degree Utilization, x	0.10	0.17	0.18	0.44
Capacity (veh/h)	622	660	699	759
Control Delay (s)	8.7	8.9	8.9	11.1
Approach Delay (s)	8.7	8.9	8.9	11.1
Approach LOS	A	A	A	B

Intersection Summary			
Delay	10.0		
HCM Level of Service	B		
Intersection Capacity Utilization	38.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
30: US-56 & I-35 NB Loop PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	540	1200	0	670	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	607	1348	0	753	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked						
vC, conflicting volume			1955		983	303
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1955		983	303
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			303		249	699

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	303	303	1348	376	376
Volume Left	0	0	0	0	0
Volume Right	0	0	1348	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.18	0.18	0.79	0.22	0.22
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	77.6%	ICU Level of Service	D
Analysis Period (min)	15		

BNSF NEPA Traffic Study 2015 Gardner Proposed Action + Indirect Effects - (Mitigated)
80: 191st Street & Driveway A PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	5	10	110	90	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	11	120	98	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	130				87	71
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	130				87	71
tC, single (s)	5.1				7.4	7.2
tC, 2 stage (s)						
tF (s)	3.1				4.4	4.2
p0 queue free %	99				86	99
cM capacity (veh/h)	1021				717	775

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	11	130	98	5
Volume Left	5	0	98	0
Volume Right	0	120	0	5
cSH	1021	1700	717	775
Volume to Capacity	0.01	0.08	0.14	0.01
Queue Length 95th (ft)	0	0	12	1
Control Delay (s)	4.3	0.0	10.8	9.7
Lane LOS	A		B	A
Approach Delay (s)	4.3	0.0	10.7	
Approach LOS			B	

Intersection Summary			
Average Delay	4.7		
Intersection Capacity Utilization	19.0%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Gardner IMF Operations + Induced Development - (Mitigated) - PM Peak Hour - Synchro Intersection LOS

81: 191st Street & Driveway B

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	90	110	130	150	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	98	120	141	163	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	261				310	190
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	261				310	190
tC, single (s)	4.6				6.5	6.6
tC, 2 stage (s)						
tF (s)	2.7				3.6	3.7
p0 queue free %	99				75	99
cM capacity (veh/h)	1070				665	763

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	109	261	163	11
Volume Left	11	0	163	0
Volume Right	0	141	0	11
cSH	1070	1700	665	763
Volume to Capacity	0.01	0.15	0.25	0.01
Queue Length 95th (ft)	1	0	24	1
Control Delay (s)	0.9	0.0	12.2	9.8
Lane LOS	A		B	A
Approach Delay (s)	0.9	0.0	12.0	
Approach LOS			B	

Intersection Summary			
Average Delay	4.0		
Intersection Capacity Utilization	28.7%	ICU Level of Service	A
Analysis Period (min)	15		

82: Driveway C & Waverly Road

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	5	5	5	60	60	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	5	65	65	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	144	68	71			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	144	68	71			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	99	99	100			
cM capacity (veh/h)	850	1001	1543			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	5	5	71	71
Volume Left	5	0	5	0
Volume Right	0	5	0	5
cSH	850	1001	1543	1700
Volume to Capacity	0.01	0.01	0.00	0.04
Queue Length 95th (ft)	0	0	0	0
Control Delay (s)	9.3	8.6	0.6	0.0
Lane LOS	A	A	A	
Approach Delay (s)	8.9		0.6	0.0
Approach LOS	A			

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	17.3%	ICU Level of Service	A
Analysis Period (min)	15		

83: Driveway D & Waverly Road

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	150	80	70	50	40	120
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	163	87	76	54	43	130
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	315	109	174			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	315	109	174			
tC, single (s)	6.5	6.3	4.3			
tC, 2 stage (s)						
tF (s)	3.6	3.4	2.3			
p0 queue free %	74	91	94			
cM capacity (veh/h)	629	921	1322			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	163	87	130	174
Volume Left	163	0	76	0
Volume Right	0	87	0	130
cSH	629	921	1322	1700
Volume to Capacity	0.26	0.09	0.06	0.10
Queue Length 95th (ft)	26	8	5	0
Control Delay (s)	12.7	9.3	4.8	0.0
Lane LOS	B	A	A	
Approach Delay (s)	11.5		4.8	0.0
Approach LOS	B			

Intersection Summary			
Average Delay	6.3		
Intersection Capacity Utilization	34.3%	ICU Level of Service	A
Analysis Period (min)	15		

84: 191st Street & Driveway E

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	95	115	5	5	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	103	125	5	5	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	130				242	128
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	130				242	128
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	99
cM capacity (veh/h)	1467				748	928

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	109	130	11
Volume Left	5	0	5
Volume Right	0	5	5
cSH	1467	1700	828
Volume to Capacity	0.00	0.08	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.4	0.0	9.4
Lane LOS	A		A
Approach Delay (s)	0.4	0.0	9.4
Approach LOS			A

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	19.1%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner IMF Operations + Induced Development - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

1: 175th Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Volume (vph)	70	20	640	10	10	10	370	230	10	20	240	50
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.92		1.00	0.99		1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1736	1677		1805	1850		1770	3486		1805	3397	
Flt Permitted	0.74	1.00		0.22	1.00		0.57	1.00		0.60	1.00	
Satd. Flow (perm)	1357	1677		422	1850		1053	3486		1131	3397	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	21	674	11	11	11	389	242	11	21	253	53
RTOR Reduction (vph)	0	464	0	0	9	0	0	3	0	0	12	0
Lane Group Flow (vph)	74	231	0	11	13	0	389	250	0	21	294	0
Heavy Vehicles (%)	4%	0%	2%	0%	0%	0%	2%	3%	0%	0%	3%	6%
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	18.0	18.0		18.0	18.0		62.0	51.6		51.2	45.8	
Effective Green, g (s)	18.0	18.0		18.0	18.0		62.0	51.6		51.2	45.8	
Actuated g/C Ratio	0.20	0.20		0.20	0.20		0.69	0.57		0.57	0.51	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	271	335		84	370		815	1999		684	1729	
v/s Ratio Prot		c0.14			0.01		c0.06	0.07		0.00	0.09	
v/s Ratio Perm	0.05			0.03			c0.27			0.02		
v/c Ratio	0.27	0.69		0.13	0.04		0.48	0.13		0.03	0.17	
Uniform Delay, d1	30.5	33.4		29.6	29.0		6.9	8.8		8.5	11.9	
Progression Factor	1.00	1.00		1.00	1.00		0.83	0.44		1.00	1.00	
Incremental Delay, d2	0.5	5.8		0.7	0.0		0.4	0.1		0.0	0.2	
Delay (s)	31.0	39.2		30.3	29.0		6.2	4.0		8.5	12.1	
Level of Service	C	D		C	C		A	A		A	B	
Approach Delay (s)		38.4			29.5			5.3			11.9	
Approach LOS		D			C			A			B	

Intersection Summary			
HCM Average Control Delay	21.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	79.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

2: US 56 & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↑	↱	↰	↑↑	↱	↰↰	↑↱	
Volume (vph)	140	820	60	170	450	270	70	990	300	360	830	190
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.97	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1752	3585	1583	1687	3486	1553	1752	3689	1553	3367	3413	
Flt Permitted	0.40	1.00	1.00	0.16	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	746	3585	1583	279	3486	1553	1752	3689	1553	3367	3413	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	147	863	63	179	474	284	74	1042	316	379	874	200
RTOR Reduction (vph)	0	0	40	0	0	204	0	0	119	0	21	0
Lane Group Flow (vph)	147	863	23	179	474	80	74	1042	197	379	1053	0
Heavy Vehicles (%)	3%	6%	2%	7%	9%	4%	3%	3%	4%	4%	3%	2%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			
Actuated Green, G (s)	31.6	25.0	25.0	32.6	25.5	25.5	5.6	29.5	29.5	11.7	35.6	
Effective Green, g (s)	31.6	25.0	25.0	32.6	25.5	25.5	5.6	29.5	29.5	11.7	35.6	
Actuated g/C Ratio	0.35	0.28	0.28	0.36	0.28	0.28	0.06	0.33	0.33	0.13	0.40	
Clearance Time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	336	996	440	212	988	440	109	1209	509	438	1350	
v/s Ratio Prot	0.03	c0.24		c0.07	0.14		0.04	c0.28		c0.11	0.31	
v/s Ratio Perm	0.12		0.01	0.24		0.05			0.13			
v/c Ratio	0.44	0.87	0.05	0.84	0.48	0.18	0.68	0.86	0.39	0.87	0.78	
Uniform Delay, d1	20.8	30.9	23.8	22.4	26.7	24.4	41.3	28.3	23.3	38.4	23.8	
Progression Factor	0.56	0.66	0.56	1.35	1.05	2.70	0.74	0.60	0.23	1.00	1.00	
Incremental Delay, d2	0.8	9.4	0.2	24.0	1.6	0.9	10.9	4.6	0.3	16.2	2.9	
Delay (s)	12.4	29.9	13.5	54.3	29.6	66.6	41.5	21.5	5.8	54.5	26.7	
Level of Service	B	C	B	D	C	E	D	C	A	D	C	
Approach Delay (s)		26.5			45.5			19.0			34.0	
Approach LOS		C			D			B			C	

Intersection Summary			
HCM Average Control Delay	30.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	19.2
Intersection Capacity Utilization	83.6%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

3: US 56 & Elm

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱			↰↑↱		↰	↱		↰	↱	
Volume (vph)	20	1480	10	10	830	90	10	10	30	110	10	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			0.99		1.00	0.89		1.00	0.88	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3436			3313		1805	1651		1770	1610	
Flt Permitted		0.93			0.93		0.72	1.00		0.73	1.00	
Satd. Flow (perm)		3211			3082		1373	1651		1358	1610	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	1558	11	11	874	95	11	11	32	116	11	42
RTOR Reduction (vph)	0	0	0	0	6	0	0	28	0	0	37	0
Lane Group Flow (vph)	0	1590	0	0	974	0	11	15	0	116	16	0
Heavy Vehicles (%)	0%	5%	0%	0%	8%	2%	0%	0%	3%	2%	0%	5%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		69.5			69.5		11.5	11.5		11.5	11.5	
Effective Green, g (s)		69.5			69.5		11.5	11.5		11.5	11.5	
Actuated g/C Ratio		0.77			0.77		0.13	0.13		0.13	0.13	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2480			2380		175	211		174	206	
v/s Ratio Prot								0.01			0.01	
v/s Ratio Perm		c0.50			0.32		0.01			c0.09		
v/c Ratio		0.64			0.41		0.06	0.07		0.67	0.08	
Uniform Delay, d1		4.6			3.4		34.5	34.6		37.4	34.6	
Progression Factor		0.66			0.98		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.8			0.5		0.2	0.1		9.3	0.2	
Delay (s)		3.9			3.8		34.7	34.7		46.7	34.8	
Level of Service		A			A		C	C		D	C	
Approach Delay (s)		3.9			3.8			34.7			43.0	
Approach LOS		A			A			C			D	

Intersection Summary			
HCM Average Control Delay	6.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	75.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

4: US 56 & Mulberry

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱			↰↑↱		↰	↱		↰	↱	
Volume (vph)	40	1630	10	10	900	60	5	5	20	100	5	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			0.99		1.00	0.88		1.00	0.87	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3432			3341		1805	1548		1770	1612	
Flt Permitted		0.90			0.93		0.73	1.00		0.74	1.00	
Satd. Flow (perm)		3090			3096		1393	1548		1379	1612	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	42	1716	11	11	947	63	5	5	21	105	5	32
RTOR Reduction (vph)	0	0	0	0	4	0	0	19	0	0	28	0
Lane Group Flow (vph)	0	1769	0	0	1017	0	5	7	0	105	9	0
Heavy Vehicles (%)	5%	5%	0%	0%	7%	8%	0%	20%	5%	2%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		71.0			71.0		10.0	10.0		10.0	10.0	
Effective Green, g (s)		71.0			71.0		10.0	10.0		10.0	10.0	
Actuated g/C Ratio		0.79			0.79		0.11	0.11		0.11	0.11	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2438			2442		155	172		153	179	
v/s Ratio Prot								0.00			0.01	
v/s Ratio Perm		c0.57			0.33		0.00			c0.08		
v/c Ratio		0.73			0.42		0.03	0.04		0.69	0.05	
Uniform Delay, d1		4.7			3.0		35.7	35.7		38.5	35.7	
Progression Factor		0.41			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.6			0.1		0.1	0.1		12.0	0.1	
Delay (s)		3.5			3.1		35.8	35.8		50.5	35.9	
Level of Service		A			A		D	D		D	D	
Approach Delay (s)		3.5			3.1			35.8			46.7	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	5.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	93.8%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner IMF Operations + Induced Development - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

5: US 56 & Moonlight Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	170	1400	190	150	700	600	150	620	270	1170	530	120
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1719	3619	1568	1770	3486	1583	1770	3725	1553	3433	3539	1553
Flt Permitted	0.21	1.00	1.00	0.10	1.00	1.00	0.44	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	381	3619	1568	188	3486	1583	825	3725	1553	3433	3539	1553
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	179	1474	200	158	737	632	158	653	284	1232	558	126
RTOR Reduction (vph)	0	0	54	0	0	341	0	0	81	0	0	86
Lane Group Flow (vph)	179	1474	146	158	737	291	158	653	203	1232	558	40
Heavy Vehicles (%)	5%	5%	3%	2%	9%	2%	2%	2%	4%	2%	2%	4%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		custom	Prot		Perm
Protected Phases	5	2		1	6		3	8	8	7	4	
Permitted Phases	2		2	6		6	8		8			4
Actuated Green, G (s)	51.5	42.6	42.6	45.7	39.7	39.7	28.4	18.5	18.5	29.9	38.5	38.5
Effective Green, g (s)	51.5	42.6	42.6	45.7	39.7	39.7	28.4	18.5	18.5	29.9	38.5	38.5
Actuated g/C Ratio	0.43	0.36	0.36	0.38	0.33	0.33	0.24	0.15	0.15	0.25	0.32	0.32
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	263	1285	557	151	1153	524	273	574	239	855	1135	498
v/s Ratio Prot	0.05	c0.41		c0.05	0.21		0.05	c0.18	0.13	c0.36	0.16	
v/s Ratio Perm	0.24		0.09	0.35		0.18	0.09					0.03
v/c Ratio	0.68	1.15	0.26	1.05	0.64	0.55	0.58	1.14	0.85	1.44	0.49	0.08
Uniform Delay, d1	23.8	38.7	27.5	34.2	34.1	32.9	38.4	50.7	49.4	45.1	32.9	28.4
Progression Factor	1.00	1.00	1.00	1.12	0.92	1.21	0.89	0.81	0.67	1.00	1.00	1.00
Incremental Delay, d2	5.7	75.7	1.1	82.6	2.5	3.8	1.5	78.8	19.4	205.1	0.1	0.0
Delay (s)	29.4	114.4	28.7	120.7	33.8	43.6	35.6	120.0	52.8	250.1	33.0	28.4
Level of Service	C	F	C	F	C	D	D	F	D	F	C	C
Approach Delay (s)		97.0			46.9			90.4			172.3	
Approach LOS		F			D			F			F	

Intersection Summary			
HCM Average Control Delay	106.5	HCM Level of Service	F
HCM Volume to Capacity ratio	1.23		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	113.9%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

6: Old US 56 & US 56 — AM Peak Hour

Movement	NBL	NBR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	160	10	1870	980	10	1310
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	0.97	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	3433	1615	3654	1583	1805	3585
Flt Permitted	0.95	1.00	1.00	1.00	0.06	1.00
Satd. Flow (perm)	3433	1615	3654	1583	118	3585
Peak-hour factor, PHF	0.97	0.97	0.95	0.95	0.95	0.95
Adj. Flow (vph)	165	10	1968	1032	11	1379
RTOR Reduction (vph)	0	9	0	122	0	0
Lane Group Flow (vph)	165	1	1968	910	11	1379
Heavy Vehicles (%)	2%	0%	4%	2%	0%	6%
Turn Type		Perm		pm+ov	pm+pt	
Protected Phases	8		2	8	1	6
Permitted Phases		8	2	2	6	6
Actuated Green, G (s)	13.4	13.4	90.4	103.8	96.6	96.6
Effective Green, g (s)	13.4	13.4	90.4	103.8	96.6	96.6
Actuated g/C Ratio	0.11	0.11	0.75	0.86	0.80	0.80
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	383	180	2753	1435	112	2886
v/s Ratio Prot	0.05		c0.54	c0.07	0.00	c0.38
v/s Ratio Perm		0.00		0.50	0.08	
v/c Ratio	0.43	0.01	0.71	0.63	0.10	0.48
Uniform Delay, d1	49.7	47.4	7.9	2.4	9.4	3.7
Progression Factor	1.00	1.00	0.68	17.00	1.29	1.28
Incremental Delay, d2	0.8	0.0	0.1	0.1	0.2	0.3
Delay (s)	50.5	47.4	5.5	41.2	12.3	5.1
Level of Service	D	D	A	D	B	A
Approach Delay (s)	50.3		17.8			5.1
Approach LOS	D		B			A

Intersection Summary			
HCM Average Control Delay	15.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	72.3%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

7: US-56 & Cedar Niles — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	2050	160	680	2120	100	130	30	760	60	20	70
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2	5.2	5.2	5.2	5.2
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00	1.00	1.00	0.88	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1787	3689	1583	3433	3689	1583	1770	1942	2787	1752	2000	1553
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.74	1.00	1.00	0.74	1.00	1.00
Satd. Flow (perm)	1787	3689	1583	3433	3689	1583	1385	1942	2787	1358	2000	1553
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	2158	168	716	2232	105	137	32	800	63	21	74
RTOR Reduction (vph)	0	0	67	0	0	28	0	0	0	0	0	65
Lane Group Flow (vph)	74	2158	101	716	2232	77	137	32	800	63	21	9
Heavy Vehicles (%)	1%	3%	2%	2%	3%	2%	2%	3%	2%	3%	0%	4%
Turn Type	Prot		Perm	Prot		Perm	Perm		pt+ov	Perm		Perm
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases			2			6	8			4		4
Actuated Green, G (s)	5.6	68.8	68.8	23.0	86.2	86.2	12.6	12.6	40.8	12.6	12.6	12.6
Effective Green, g (s)	5.6	68.8	68.8	23.0	86.2	86.2	12.6	12.6	40.8	12.6	12.6	12.6
Actuated g/C Ratio	0.05	0.57	0.57	0.19	0.72	0.72	0.10	0.10	0.34	0.10	0.10	0.10
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2		5.2	5.2	5.2
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lane Grp Cap (vph)	83	2115	908	658	2650	1137	145	204	948	143	210	163
v/s Ratio Prot	0.04	c0.58		c0.21	0.60			0.02	c0.29		0.01	
v/s Ratio Perm			0.06			0.05	0.10			0.05		0.01
v/c Ratio	0.89	1.02	0.11	1.09	0.84	0.07	0.94	0.16	0.84	0.44	0.10	0.05
Uniform Delay, d1	56.9	25.6	11.7	48.5	12.1	5.0	53.4	48.9	36.7	50.4	48.6	48.3
Progression Factor	0.86	0.74	0.37	1.07	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	55.7	23.2	0.2	42.5	0.3	0.0	57.3	0.1	6.7	0.8	0.1	0.0
Delay (s)	104.8	42.2	4.5	94.3	12.4	5.0	110.7	49.0	43.3	51.2	48.6	48.4
Level of Service	F	D	A	F	B	A	F	D	D	D	D	D
Approach Delay (s)		41.5			31.3			53.0			49.5	
Approach LOS		D			C			D			D	

Intersection Summary			
HCM Average Control Delay	38.7	HCM Level of Service	D
HCM Volume to Capacity ratio	1.04		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.6
Intersection Capacity Utilization	102.8%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

8: US-56 & I-35 SB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	2740	90	350	1470	0	0	0	0	210	0	1380
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		1.00		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3509		1719	3725					1736		2760
Flt Permitted		1.00		0.11	1.00					0.95		1.00
Satd. Flow (perm)		3509		202	3725					1736		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2884	95	368	1547	0	0	0	0	221	0	1453
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	2977	0	368	1547	0	0	0	0	221	0	1453
Heavy Vehicles (%)	0%	2%	14%	5%	2%	0%	0%	0%	0%	4%	0%	3%
Turn Type				pm+pt						custom		custom
Protected Phases		2		1	6					4		5
Permitted Phases				6						4		4
Actuated Green, G (s)		77.0		51.8	51.8					12.0		53.2
Effective Green, g (s)		77.0		51.8	51.8					12.0		53.2
Actuated g/C Ratio		0.64		0.43	0.43					0.10		0.44
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2252		289	1608					174		1339
v/s Ratio Prot		c0.85		c0.17	0.42					0.13		c0.37
v/s Ratio Perm				0.38								0.15
v/c Ratio		1.32		1.27	0.96					1.27		1.09
Uniform Delay, d1		21.5		35.7	33.1					54.0		33.4
Progression Factor		0.72		0.90	0.87					1.00		1.00
Incremental Delay, d2		145.9		139.8	10.7					158.8		51.1
Delay (s)		161.4		171.8	39.5					212.8		84.5
Level of Service		F		F	D					F		F
Approach Delay (s)		161.4			65.0			0.0			101.5	
Approach LOS		F			E			A			F	

Intersection Summary			
HCM Average Control Delay	118.0	HCM Level of Service	F
HCM Volume to Capacity ratio	1.26		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	121.3%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner IMF Operations + Induced Development - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

9: US-56 & I-35 NB Ramps

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑			↑↑	↱	↰	↱	↱			
Volume (vph)	0	1320	0	0	1650	510	170	0	690	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95	0.95			
Frt		1.00			1.00	0.85	1.00	0.85	0.85			
Flt Protected		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (prot)		3725			3539	1583	1687	1490	1490			
Flt Permitted		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (perm)		3725			3539	1583	1687	1490	1490			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1389	0	0	1737	537	179	0	726	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	106	0	0	0	0	0	0
Lane Group Flow (vph)	0	1389	0	0	1737	431	179	363	363	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	2%	7%	0%	3%	0%	0%	0%
Turn Type						Perm	Perm		Perm			
Protected Phases		2			6			8				
Permitted Phases						6	8		8			
Actuated Green, G (s)		75.2			75.2	75.2	34.8	34.8	34.8			
Effective Green, g (s)		75.2			75.2	75.2	34.8	34.8	34.8			
Actuated g/C Ratio		0.63			0.63	0.63	0.29	0.29	0.29			
Clearance Time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0	3.0			
Lane Grp Cap (vph)		2334			2218	992	489	432	432			
v/s Ratio Prot		0.37			c0.49			c0.24				
v/s Ratio Perm						0.27	0.11		0.24			
v/c Ratio		0.60			0.78	0.43	0.37	0.84	0.84			
Uniform Delay, d1		13.3			16.4	11.5	33.8	40.0	40.0			
Progression Factor		0.49			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2		0.1			1.9	0.3	0.5	13.7	13.7			
Delay (s)		6.7			18.3	11.8	34.3	53.7	53.7			
Level of Service		A			B	B	C	D	D			
Approach Delay (s)		6.7			16.8			49.9			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	20.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	104.3%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

10: Santa Fe & Moonlight Road

AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰	↱	↑↱		↰	↑↑
Volume (vph)	120	330	710	240	460	410
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.96		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3380		1770	3505
Flt Permitted	0.95	1.00	1.00		0.21	1.00
Satd. Flow (perm)	1770	1583	3380		393	3505
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	126	347	747	253	484	432
RTOR Reduction (vph)	0	307	21	0	0	0
Lane Group Flow (vph)	126	40	979	0	484	432
Heavy Vehicles (%)	2%	2%	3%	2%	2%	3%
Turn Type		Perm			pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8			6	
Actuated Green, G (s)	13.8	13.8	63.9		96.2	96.2
Effective Green, g (s)	13.8	13.8	63.9		96.2	96.2
Actuated g/C Ratio	0.12	0.12	0.53		0.80	0.80
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	204	182	1800		628	2810
v/s Ratio Prot	c0.07		0.29		c0.18	0.12
v/s Ratio Perm		0.03			c0.44	
v/c Ratio	0.62	0.22	0.54		0.77	0.15
Uniform Delay, d1	50.6	48.2	18.5		18.5	2.7
Progression Factor	1.00	1.00	1.00		0.61	0.80
Incremental Delay, d2	5.5	0.6	1.2		4.9	0.1
Delay (s)	56.1	48.8	19.6		16.2	2.2
Level of Service	E	D	B		B	A
Approach Delay (s)	50.7		19.6			9.6
Approach LOS	D		B			A

Intersection Summary			
HCM Average Control Delay	22.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	71.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

11: Waverly Road & US 56

AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰	↑↑	↱	↰↰	↑↱		↰	↑↑	↱	↰	↑↑	↱
Volume (vph)	20	250	140	550	280	40	70	140	20	200	70	300
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95		1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.98		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1805	3539	1482	3400	3469		1736	3312	1615	1736	2935	1568
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1805	3539	1482	3400	3469		1736	3312	1615	1736	2935	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	263	147	579	295	42	74	147	21	211	74	316
RTOR Reduction (vph)	0	0	127	0	13	0	0	0	18	0	0	223
Lane Group Flow (vph)	21	263	20	579	324	0	74	147	3	211	74	93
Heavy Vehicles (%)	0%	2%	9%	3%	1%	10%	4%	9%	0%	4%	23%	3%
Turn Type	Prot		Perm	Prot			Prot		Perm	Prot		Perm
Protected Phases	3	8		7	4		5	2		1	6	
Permitted Phases			8					2	2			6
Actuated Green, G (s)	3.1	12.1	12.1	23.5	32.5		7.9	12.2	12.2	22.2	26.5	26.5
Effective Green, g (s)	3.1	12.1	12.1	23.5	32.5		7.9	12.2	12.2	22.2	26.5	26.5
Actuated g/C Ratio	0.03	0.13	0.13	0.26	0.36		0.09	0.14	0.14	0.25	0.29	0.29
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	62	476	199	888	1253		152	449	219	428	864	462
v/s Ratio Prot	0.01	c0.07		c0.17	0.09		0.04	c0.04		c0.12	0.03	
v/s Ratio Perm			0.01						0.00			0.06
v/c Ratio	0.34	0.55	0.10	0.65	0.26		0.49	0.33	0.01	0.49	0.09	0.20
Uniform Delay, d1	42.4	36.4	34.2	29.6	20.3		39.1	35.2	33.7	29.1	23.0	23.8
Progression Factor	0.98	0.98	0.93	0.96	0.95		0.87	0.84	0.71	1.15	0.69	0.62
Incremental Delay, d2	3.2	1.4	0.2	1.5	0.1		2.2	1.8	0.1	0.8	0.2	0.8
Delay (s)	45.0	37.1	32.1	29.9	19.4		36.3	31.4	23.9	34.3	16.0	15.7
Level of Service	D	D	C	C	B		D	C	C	C	B	B
Approach Delay (s)		35.8			26.0			32.3			22.3	
Approach LOS		D			C			C			C	

Intersection Summary			
HCM Average Control Delay	27.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	54.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

12: 183rd Street & Four Corners Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✥			✥			✥			✥	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	20	5	5	40	5	10	20	5	5	50	5
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	21	5	5	42	5	11	21	5	5	53	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	32	53	37	63
Volume Left (vph)	5	5	11	5
Volume Right (vph)	5	5	5	5
Hadj (s)	-0.07	0.00	0.02	0.02
Departure Headway (s)	4.1	4.2	4.2	4.1
Degree Utilization, x	0.04	0.06	0.04	0.07
Capacity (veh/h)	849	842	834	847
Control Delay (s)	7.3	7.4	7.4	7.5
Approach Delay (s)	7.3	7.4	7.4	7.5
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.4		
HCM Level of Service	A		
Intersection Capacity Utilization	14.4%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner IMF Operations + Induced Development - (Improved) - AM Peak Hour - Synchro Intersection LOS

13: 183rd Street & US 56

AM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	30	0	0	200	80	40
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	32	0	0	211	84	42
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	316	105	126			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	316	105	126			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	95	100	100			
cM capacity (veh/h)	681	955	1473			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	32	211	126
Volume Left	32	0	0
Volume Right	0	0	42
cSH	681	1473	1700
Volume to Capacity	0.05	0.00	0.07
Queue Length 95th (ft)	4	0	0
Control Delay (s)	10.5	0.0	0.0
Lane LOS	B		
Approach Delay (s)	10.5	0.0	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	20.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study 2030 Gardner Proposed Action + Indirect Effects - (Imp)

14: 183rd Street & Waverly Road

AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	20	230	240	20	180	210
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	242	253	21	189	221
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	863	263			274	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	863	263			274	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	92	69			85	
cM capacity (veh/h)	280	780			1301	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	263	274	411
Volume Left	21	0	189
Volume Right	242	21	0
cSH	683	1700	1301
Volume to Capacity	0.39	0.16	0.15
Queue Length 95th (ft)	45	0	13
Control Delay (s)	13.5	0.0	4.5
Lane LOS	B		A
Approach Delay (s)	13.5	0.0	4.5
Approach LOS	B		

Intersection Summary			
Average Delay	5.7		
Intersection Capacity Utilization	60.2%	ICU Level of Service	B
Analysis Period (min)	15		

BNSF NEPA Traffic Study 2030 Gardner Proposed Action + Indirect Effects - (Imp)

15: 183rd Street & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	120	80	200	240	120	120	200	1050	210	90	920	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.89		1.00	0.92		1.00	0.98		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1658		1770	1723		1787	3423		1770	3452	
Flt Permitted	0.48	1.00		0.23	1.00		0.20	1.00		0.11	1.00	
Satd. Flow (perm)	896	1658		421	1723		371	3423		205	3452	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	126	84	211	253	126	126	211	1105	221	95	968	116
RTOR Reduction (vph)	0	103	0	0	0	0	0	17	0	0	10	0
Lane Group Flow (vph)	126	192	0	253	252	0	211	1309	0	95	1074	0
Heavy Vehicles (%)	2%	3%	2%	2%	2%	2%	1%	3%	2%	2%	3%	2%
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	19.7	13.7		27.7	17.7		42.4	42.4		40.3	40.3	
Effective Green, g (s)	19.7	13.7		27.7	17.7		42.4	42.4		40.3	40.3	
Actuated g/C Ratio	0.22	0.15		0.31	0.20		0.47	0.47		0.45	0.45	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	254	252		279	339		269	1613		160	1546	
v/s Ratio Prot	0.03	0.12		c0.10	0.15		0.05	c0.38		0.03	c0.31	
v/s Ratio Perm	0.08			c0.18			0.32			0.24		
v/c Ratio	0.50	0.76		0.91	0.74		0.78	0.81		0.59	0.69	
Uniform Delay, d1	29.6	36.6		26.8	34.0		26.9	20.4		20.0	19.9	
Progression Factor	1.14	1.11		1.00	1.00		0.69	0.62		0.64	0.80	
Incremental Delay, d2	1.5	12.6		30.5	8.5		10.0	3.2		4.1	1.8	
Delay (s)	35.3	53.1		57.3	42.5		28.6	15.8		16.9	17.7	
Level of Service	D	D		E	D		C	B		B	B	
Approach Delay (s)		47.8			49.9			17.6			17.6	
Approach LOS		D			D			B			B	

Intersection Summary			
HCM Average Control Delay	25.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	87.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study 2030 Gardner Proposed Action + Indirect Effects - (Imp)

16: Four Corners Road & US 56

AM Peak Hour

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	0	50	30	190	80	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	0	53	32	200	84	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	347	84	84			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	347	84	84			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	95	98			
cM capacity (veh/h)	640	975	1506			

Direction, Lane #	SB 1	NE 1	SW 1
Volume Total	53	232	84
Volume Left	0	32	0
Volume Right	53	0	0
cSH	975	1506	1700
Volume to Capacity	0.05	0.02	0.05
Queue Length 95th (ft)	4	2	0
Control Delay (s)	8.9	1.2	0.0
Lane LOS	A	A	
Approach Delay (s)	8.9	1.2	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	2.0		
Intersection Capacity Utilization	28.3%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner IMF Operations + Induced Development - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

17: 191st Street & US 56

AM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	20	5	5	200	70	60
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	5	5	211	74	63
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	326	105	137			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	326	105	137			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	99	100			
cM capacity (veh/h)	670	955	1460			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	26	216	137
Volume Left	21	5	0
Volume Right	5	0	63
cSH	712	1460	1700
Volume to Capacity	0.04	0.00	0.08
Queue Length 95th (ft)	3	0	0
Control Delay (s)	10.2	0.2	0.0
Lane LOS	B	A	
Approach Delay (s)	10.2	0.2	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	24.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

18: 191st Street & Four Corners Road

AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	10	10	110	30	30	120
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.95	0.92	0.92	0.95
Hourly flow rate (vph)	11	11	116	33	33	126
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			22		280	16
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			22		280	16
tC, single (s)			5.0		6.6	7.1
tC, 2 stage (s)						
tF (s)			3.0		3.7	4.1
p0 queue free %			90		95	85
cM capacity (veh/h)			1157		611	860

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	22	148	159
Volume Left	0	116	33
Volume Right	11	0	126
cSH	1700	1157	794
Volume to Capacity	0.01	0.10	0.20
Queue Length 95th (ft)	0	8	19
Control Delay (s)	0.0	6.8	10.7
Lane LOS		A	B
Approach Delay (s)	0.0	6.8	10.7
Approach LOS			B

Intersection Summary			
Average Delay	8.2		
Intersection Capacity Utilization	30.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

19: 191st Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	90	70	70	10	160	50	40	110	30	50	50	130
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	95	74	74	11	168	53	42	116	32	53	53	137
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	221			147			679	542	111	605	553	195
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	221			147			679	542	111	605	553	195
tC, single (s)	4.2			4.1			7.3	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.3			2.2			3.7	4.0	3.3	3.5	4.0	3.3
p0 queue free %	93			99			83	72	97	82	87	84
cM capacity (veh/h)	1313			1447			243	412	940	294	406	844

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	242	232	189	242
Volume Left	95	11	42	53
Volume Right	74	53	32	137
cSH	1313	1447	388	515
Volume to Capacity	0.07	0.01	0.49	0.47
Queue Length 95th (ft)	6	1	65	62
Control Delay (s)	3.5	0.4	22.8	18.1
Lane LOS	A	A	C	C
Approach Delay (s)	3.5	0.4	22.8	18.1
Approach LOS			C	C

Intersection Summary			
Average Delay	10.6		
Intersection Capacity Utilization	52.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

20: W 188th Street & Gardner Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	30	260	210	30	240	330	1010	260	260	1240	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	5.0	5.0	5.0	2.5	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.87		1.00	0.97		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1787	1845	1583	1770	1613		1752	3526		1770	3689	1553
Flt Permitted	0.31	1.00	1.00	0.74	1.00		0.10	1.00		0.11	1.00	1.00
Satd. Flow (perm)	583	1845	1583	1370	1613		187	3526		206	3689	1553
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	84	33	274	228	33	261	347	1063	283	283	1305	116
RTOR Reduction (vph)	0	0	235	0	224	0	0	26	0	0	0	65
Lane Group Flow (vph)	84	33	39	228	70	0	347	1320	0	283	1305	51
Heavy Vehicles (%)	1%	3%	2%	2%	3%	2%	3%	5%	2%	2%	3%	4%
Turn Type	pm+pt		Perm	pm+pt			pm+pt			pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	16.9	12.9	12.9	19.0	12.7		56.6	39.4		50.0	36.1	36.1
Effective Green, g (s)	16.9	12.9	12.9	19.0	12.7		56.6	39.4		50.0	36.1	36.1
Actuated g/C Ratio	0.19	0.14	0.14	0.21	0.14		0.63	0.44		0.56	0.40	0.40
Clearance Time (s)	5.0	5.0	5.0	2.5	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	163	264	227	317	228		417	1544		356	1480	623
v/s Ratio Prot	0.02	0.02		c0.05	0.04		c0.16	c0.37		0.12	0.35	
v/s Ratio Perm	0.07		0.02	c0.10			0.36			0.32		0.03
v/c Ratio	0.52	0.12	0.17	0.72	0.31		0.83	0.85		0.79	0.88	0.08
Uniform Delay, d1	31.6	33.6	33.9	32.4	34.7		24.3	22.7		21.4	25.0	16.7
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.02	1.04		1.25	0.61	0.54
Incremental Delay, d2	2.7	0.2	0.4	7.6	0.8		11.3	5.3		9.4	5.3	0.0
Delay (s)	34.3	33.8	34.2	40.0	35.5		36.2	28.9		36.1	20.5	9.1
Level of Service	C	C	C	D	D		D	C		D	C	A
Approach Delay (s)		34.2			37.4			30.4			22.4	
Approach LOS		C			D			C			C	

Intersection Summary			
HCM Average Control Delay	28.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	88.3%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner IMF Operations + Induced Development - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

21: I-35 SB Ramps & Gardner Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	210	0	770	10	830	0	0	1540	170
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)				5.0	5.0	2.5	2.5	5.0			5.0	
Lane Util. Factor				1.00	0.95	0.95	1.00	0.95			0.95	
Frt				1.00	0.85	0.85	1.00	1.00			0.99	
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1703	1447	1447	1805	3689			3663	
Flt Permitted				0.95	1.00	1.00	0.10	1.00			1.00	
Satd. Flow (perm)				1703	1447	1447	191	3689			3663	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	221	0	811	11	874	0	0	1621	179
RTOR Reduction (vph)	0	0	0	0	287	40	0	0	0	0	7	0
Lane Group Flow (vph)	0	0	0	221	119	365	11	874	0	0	1793	0
Heavy Vehicles (%)	0%	0%	0%	6%	0%	6%	0%	3%	0%	0%	2%	4%
Turn Type				custom		custom	pm+pt					
Protected Phases				8	8	1	5	2			6	
Permitted Phases				8		8	2					
Actuated Green, G (s)				16.5	16.5	37.7	40.9	39.8			59.9	
Effective Green, g (s)				16.5	16.5	37.7	40.9	39.8			59.9	
Actuated g/C Ratio				0.18	0.18	0.42	0.45	0.44			0.67	
Clearance Time (s)				5.0	5.0	2.5	2.5	5.0			5.0	
Vehicle Extension (s)				3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)				312	265	646	107	1631			2438	
v/s Ratio Prot				c0.13	0.08	c0.13	0.00	0.24			c0.49	
v/s Ratio Perm						0.12	0.05					
v/c Ratio				0.71	0.45	0.56	0.10	0.54			0.74	
Uniform Delay, d1				34.5	32.7	19.9	18.0	18.3			9.9	
Progression Factor				1.00	1.00	1.00	0.61	0.52			0.48	
Incremental Delay, d2				7.2	1.2	1.1	0.1	0.3			1.2	
Delay (s)				41.7	33.9	21.0	11.1	9.8			5.9	
Level of Service				D	C	C	B	A			A	
Approach Delay (s)		0.0			30.5			9.8			5.9	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM Average Control Delay	13.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	93.3%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

22: I-35 NB Ramps & Gardner Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	360	0	40	0	0	0	0	480	450	1070	690	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0						5.0	5.0	5.0	5.0	
Lane Util. Factor		1.00						1.00	1.00	0.97	0.95	
Frt		0.99						1.00	0.85	1.00	1.00	
Flt Protected		0.96						1.00	1.00	0.95	1.00	
Satd. Flow (prot)		1753						1942	1583	3433	3725	
Flt Permitted		0.96						1.00	1.00	0.95	1.00	
Satd. Flow (perm)		1753						1942	1583	3433	3725	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	379	0	42	0	0	0	0	505	474	1126	726	0
RTOR Reduction (vph)	0	5	0	0	0	0	0	0	334	0	0	0
Lane Group Flow (vph)	0	416	0	0	0	0	0	505	140	1126	726	0
Heavy Vehicles (%)	2%	0%	5%	0%	0%	0%	0%	3%	2%	2%	2%	0%
Turn Type	Split								Perm	Prot		
Protected Phases	4	4						2		1	6	
Permitted Phases									2			
Actuated Green, G (s)		21.0						24.0	24.0	30.0	59.0	
Effective Green, g (s)		21.0						24.0	24.0	30.0	59.0	
Actuated g/C Ratio		0.23						0.27	0.27	0.33	0.66	
Clearance Time (s)		5.0						5.0	5.0	5.0	5.0	
Vehicle Extension (s)		3.0						3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)		409						518	422	1144	2442	
v/s Ratio Prot		c0.24						c0.26		c0.33	0.19	
v/s Ratio Perm									0.09			
v/c Ratio		1.02						0.97	0.33	0.98	0.30	
Uniform Delay, d1		34.5						32.7	26.6	29.8	6.6	
Progression Factor		1.00						0.86	0.87	0.80	0.54	
Incremental Delay, d2		49.2						30.4	1.8	18.6	0.2	
Delay (s)		83.7						58.4	24.9	42.3	3.8	
Level of Service		F						E	C	D	A	
Approach Delay (s)		83.7			0.0			42.2			27.2	
Approach LOS		F			A			D			C	

Intersection Summary			
HCM Average Control Delay	39.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	93.3%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

23: E 191st Street & Gardner Rd

AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	20	80	850	20	100	640
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		5.0			5.0
Lane Util. Factor	1.00		1.00			1.00
Frt	0.89		1.00			1.00
Flt Protected	0.99		1.00			0.99
Satd. Flow (prot)	1639		1840			1843
Flt Permitted	0.99		1.00			0.77
Satd. Flow (perm)	1639		1840			1425
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	84	895	21	105	674
RTOR Reduction (vph)	78	0	1	0	0	0
Lane Group Flow (vph)	27	0	915	0	0	779
Heavy Vehicles (%)	0%	3%	3%	0%	5%	2%
Turn Type					Perm	
Protected Phases	8		2			6
Permitted Phases					6	
Actuated Green, G (s)	6.4		73.6			73.6
Effective Green, g (s)	6.4		73.6			73.6
Actuated g/C Ratio	0.07		0.82			0.82
Clearance Time (s)	5.0		5.0			5.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	117		1505			1165
v/s Ratio Prot	c0.02		0.50			
v/s Ratio Perm						c0.55
v/c Ratio	0.23		0.61			0.67
Uniform Delay, d1	39.5		3.0			3.3
Progression Factor	1.00		0.75			1.21
Incremental Delay, d2	1.0		0.6			2.9
Delay (s)	40.5		2.9			6.9
Level of Service	D		A			A
Approach Delay (s)	40.5		2.9			6.9
Approach LOS	D		A			A

Intersection Summary			
HCM Average Control Delay	6.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	103.7%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

24: Sunflower Road & US 56

AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	5	40	5	270	70	10	5	190	370	10	60	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.99			1.00			0.91			1.00	
Flt Protected		1.00			0.96			1.00			0.99	
Satd. Flow (prot)		1866			1778			1665			1635	
Flt Permitted		0.97			0.74			1.00			0.92	
Satd. Flow (perm)		1811			1368			1664			1522	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	5	42	5	284	74	11	5	200	389	11	63	0
RTOR Reduction (vph)	0	3	0	0	1	0	0	67	0	0	0	0
Lane Group Flow (vph)	0	49	0	0	368	0	0	527	0	0	74	0
Heavy Vehicles (%)	0%	0%	0%	3%	1%	0%	0%	6%	3%	0%	18%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		28.2			28.2			51.8			51.8	
Effective Green, g (s)		28.2			28.2			51.8			51.8	
Actuated g/C Ratio		0.31			0.31			0.58			0.58	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		567			429			958			876	
v/s Ratio Prot												
v/s Ratio Perm		0.03			c0.27			c0.32			0.05	
v/c Ratio		0.09			0.86			0.55			0.08	
Uniform Delay, d1		21.8			29.0			11.9			8.5	
Progression Factor		1.00			0.92			0.68			1.08	
Incremental Delay, d2		0.1			11.7			2.0			0.2	
Delay (s)		21.9			38.2			10.0			9.4	
Level of Service		C			D			B			A	
Approach Delay (s)		21.9			38.2			10.0			9.4	
Approach LOS		C			D			B			A	

Intersection Summary			
HCM Average Control Delay	20.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	67.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)
25: US 56 & 4th Street — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	480	130	80	260	110	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0			5.0	5.0	
Lane Util. Factor	1.00			1.00	1.00	
Frt	0.97			1.00	0.94	
Flt Protected	1.00			0.99	0.97	
Satd. Flow (prot)	1778			1780	1676	
Flt Permitted	1.00			0.77	0.97	
Satd. Flow (perm)	1778			1388	1676	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	505	137	84	274	116	95
RTOR Reduction (vph)	8	0	0	0	36	0
Lane Group Flow (vph)	634	0	0	358	175	0
Heavy Vehicles (%)	4%	3%	4%	6%	5%	2%
Turn Type			Perm			
Protected Phases	4			8	2	
Permitted Phases			8			
Actuated Green, G (s)	65.5			65.5	14.5	
Effective Green, g (s)	65.5			65.5	14.5	
Actuated g/C Ratio	0.73			0.73	0.16	
Clearance Time (s)	5.0			5.0	5.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	1294			1010	270	
v/s Ratio Prot	c0.36				c0.10	
v/s Ratio Perm				0.26		
v/c Ratio	0.49			0.35	0.65	
Uniform Delay, d1	5.2			4.5	35.4	
Progression Factor	1.00			0.33	1.00	
Incremental Delay, d2	1.3			0.8	5.3	
Delay (s)	6.5			2.3	40.6	
Level of Service	A			A	D	
Approach Delay (s)	6.5			2.3	40.6	
Approach LOS	A			A	D	

Intersection Summary			
HCM Average Control Delay	11.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	75.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)
26: 199th Street & Four Corners Road — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	420	360	140	110	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	11	442	379	147	116	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	526				916	453
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	526				916	453
tC, single (s)	4.3				7.4	6.8
tC, 2 stage (s)						
tF (s)	2.4				4.4	3.8
p0 queue free %	99				44	99
cM capacity (veh/h)	955				206	503

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	453	526	121
Volume Left	11	0	116
Volume Right	0	147	5
cSH	955	1700	212
Volume to Capacity	0.01	0.31	0.57
Queue Length 95th (ft)	1	0	78
Control Delay (s)	0.3	0.0	42.6
Lane LOS	A		E
Approach Delay (s)	0.3	0.0	42.6
Approach LOS			E

Intersection Summary			
Average Delay	4.8		
Intersection Capacity Utilization	43.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)
27: 199th Street & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	160	10	30	170	450	10	260	20	290	90	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00		1.00		1.00	1.00	1.00
Frt	1.00	0.99		1.00	1.00	0.85		0.99		1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		1.00		0.95	1.00	1.00
Satd. Flow (prot)	1752	1782		1752	1845	1583		1830		1770	1863	1583
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.99		0.45	1.00	1.00
Satd. Flow (perm)	1752	1782		1752	1845	1583		1818		837	1863	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	42	168	11	32	179	474	11	274	21	305	95	53
RTOR Reduction (vph)	0	3	0	0	0	393	0	2	0	0	0	20
Lane Group Flow (vph)	42	176	0	32	179	81	0	304	0	305	95	33
Heavy Vehicles (%)	3%	6%	0%	3%	3%	2%	0%	3%	0%	2%	2%	2%
Turn Type	Prot			Prot		Perm	Perm			pm+pt		Perm
Protected Phases	5	2		1	6			8		7	4	
Permitted Phases						6	8			4		4
Actuated Green, G (s)	4.4	14.1		5.6	15.3	15.3		37.7		55.3	55.3	55.3
Effective Green, g (s)	4.4	14.1		5.6	15.3	15.3		37.7		55.3	55.3	55.3
Actuated g/C Ratio	0.05	0.16		0.06	0.17	0.17		0.42		0.61	0.61	0.61
Clearance Time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	86	279		109	314	269		762		645	1145	973
v/s Ratio Prot	0.02	c0.10		0.02	c0.10					c0.07	0.05	
v/s Ratio Perm						0.05		0.17		c0.22		0.02
v/c Ratio	0.49	0.63		0.29	0.57	0.30		0.40		0.47	0.08	0.03
Uniform Delay, d1	41.7	35.5		40.3	34.3	32.7		18.2		9.4	7.0	6.8
Progression Factor	1.06	1.08		1.00	1.00	1.00		1.00		1.51	1.39	2.30
Incremental Delay, d2	4.3	4.4		1.5	2.5	0.6		1.6		0.4	0.1	0.0
Delay (s)	48.7	42.7		41.8	36.8	33.3		19.8		14.6	9.9	15.7
Level of Service	D	D		D	D	C		B		B	A	B
Approach Delay (s)		43.8			34.6			19.8			13.7	
Approach LOS		D			C			B			B	

Intersection Summary			
HCM Average Control Delay	27.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	60.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)
30: US-56 & I-35 NB Loop — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	1320	1630	0	1820	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	1389	1716	0	1916	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked					0.60	
vC, conflicting volume			3105		2347	695
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			3105		1909	695
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			106		37	389

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	695	695	1716	958	958
Volume Left	0	0	0	0	0
Volume Right	0	0	1716	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.41	0.41	1.01	0.56	0.56
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	104.3%	ICU Level of Service	G
Analysis Period (min)	15		

2030 Gardner IMF Operations + Induced Development - (Improved) - AM Peak Hour - Synchro Intersection LOS

Movement	EBL	EBT	WBU	WBT	WBR	SWL	SWR
Lane Configurations							
Volume (veh/h)	10	770	0	760	170	120	10
Sign Control		Free		Free		Stop	
Grade		0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	837	0	826	185	130	11
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type		TWLTL		TWLTL			
Median storage veh)		2		2			
Upstream signal (ft)				802			
pX, platoon unblocked	0.98		0.00			0.98	0.98
vC, conflicting volume	1011		0			1777	918
vC1, stage 1 conf vol						918	
vC2, stage 2 conf vol						859	
vCu, unblocked vol	1002		0			1782	908
tC, single (s)	4.1		0.0			7.0	6.2
tC, 2 stage (s)						6.0	
tF (s)	2.2		0.0			4.0	3.3
p0 queue free %	98		0			43	97
cM capacity (veh/h)	686		0			228	330

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SW 1
Volume Total	11	837	1011	0	141
Volume Left	11	0	0	0	130
Volume Right	0	0	185	0	11
cSH	686	1700	1700	1700	234
Volume to Capacity	0.02	0.49	0.59	0.00	0.61
Queue Length 95th (ft)	1	0	0	0	88
Control Delay (s)	10.3	0.0	0.0	0.0	41.5
Lane LOS	B				E
Approach Delay (s)	0.1		0.0		41.5
Approach LOS					E

Intersection Summary			
Average Delay	3.0		
Intersection Capacity Utilization	64.3%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	820	70	50	350	0	0	0	0	10	0	580
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		1.00		1.00	1.00					1.00		1.00
Frt		0.99		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		1552		1770	1827					1805		1335
Flt Permitted		1.00		0.21	1.00					0.95		1.00
Satd. Flow (perm)		1552		388	1827					1805		1335
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	891	76	54	380	0	0	0	0	11	0	630
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	575
Lane Group Flow (vph)	0	965	0	54	380	0	0	0	0	11	0	55
Heavy Vehicles (%)	0%	22%	11%	2%	4%	0%	0%	0%	0%	0%	0%	21%
Turn Type				pm+pt						Prot		custom
Protected Phases		4		3	8					6		
Permitted Phases				8								6
Actuated Green, G (s)		65.6		75.0	75.0					5.0		5.0
Effective Green, g (s)		65.6		75.0	75.0					5.0		5.0
Actuated g/C Ratio		0.73		0.83	0.83					0.06		0.06
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		1131		391	1523					100		74
v/s Ratio Prot		c0.62		0.01	c0.21					0.01		
v/s Ratio Perm				0.11								c0.04
v/c Ratio		0.85		0.14	0.25					0.11		0.74
Uniform Delay, d1		8.7		9.0	1.6					40.4		41.9
Progression Factor		0.96		0.01	0.01					1.00		1.00
Incremental Delay, d2		8.1		0.1	0.1					0.5		32.4
Delay (s)		16.5		0.2	0.1					40.9		74.3
Level of Service		B		A	A					D		E
Approach Delay (s)		16.5			0.1			0.0			73.7	
Approach LOS		B			A			A			E	

Intersection Summary			
HCM Average Control Delay	31.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	77.0%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	750	80	0	0	160	20	240	0	90	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0		5.0			
Lane Util. Factor	1.00	1.00			1.00		1.00		1.00			
Frt	1.00	1.00			0.98		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1456	1759			1823		1736		1583			
Flt Permitted	0.49	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	749	1759			1823		1736		1583			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	815	87	0	0	174	22	261	0	98	0	0	0
RTOR Reduction (vph)	0	0	0	0	5	0	0	0	81	0	0	0
Lane Group Flow (vph)	815	87	0	0	191	0	261	0	17	0	0	0
Heavy Vehicles (%)	24%	8%	0%	0%	3%	0%	4%	0%	2%	0%	0%	0%
Turn Type	pm+pt						custom		custom			
Protected Phases	7	4			8							
Permitted Phases	4						2		2			
Actuated Green, G (s)	64.5	64.5			13.8		15.5		15.5			
Effective Green, g (s)	64.5	64.5			13.8		15.5		15.5			
Actuated g/C Ratio	0.72	0.72			0.15		0.17		0.17			
Clearance Time (s)	5.0	5.0			5.0		5.0		5.0			
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Lane Grp Cap (vph)	896	1261			280		299		273			
v/s Ratio Prot	c0.46	0.05			0.10							
v/s Ratio Perm	c0.19						c0.15		0.01			
v/c Ratio	0.91	0.07			0.68		0.87		0.06			
Uniform Delay, d1	12.6	3.8			36.0		36.3		31.2			
Progression Factor	0.71	0.13			1.02		1.00		1.00			
Incremental Delay, d2	7.5	0.1			6.5		23.3		0.1			
Delay (s)	16.5	0.5			43.4		59.6		31.3			
Level of Service	B	A			D		E		C			
Approach Delay (s)		14.9			43.4			51.8			0.0	
Approach LOS		B			D			D			A	

Intersection Summary			
HCM Average Control Delay	27.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	77.0%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	160	10	5	170	10	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	174	11	5	185	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	820					
pX, platoon unblocked						
vC, conflicting volume			185		375	179
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			185		375	179
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	99
cM capacity (veh/h)			1402		628	869

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	185	190	16
Volume Left	0	5	11
Volume Right	11	0	5
cSH	1700	1402	692
Volume to Capacity	0.11	0.00	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.2	10.3
Lane LOS		A	B
Approach Delay (s)	0.0	0.2	10.3
Approach LOS			B

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	23.0%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner IMF Operations + Induced Development - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)
80: 191st Street & Driveway A
AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	110	10	30	10	70	110
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	120	11	33	11	76	120
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	43				288	38
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	43				288	38
tC, single (s)	5.1				7.4	7.2
tC, 2 stage (s)						
tF (s)	3.1				4.4	4.2
p0 queue free %	89				84	85
cM capacity (veh/h)	1112				479	812

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	130	43	76	120
Volume Left	120	0	76	0
Volume Right	0	11	0	120
cSH	1112	1700	479	812
Volume to Capacity	0.11	0.03	0.16	0.15
Queue Length 95th (ft)	9	0	14	13
Control Delay (s)	8.0	0.0	13.9	10.2
Lane LOS	A		B	B
Approach Delay (s)	8.0	0.0	11.6	
Approach LOS			B	

Intersection Summary			
Average Delay	9.0		
Intersection Capacity Utilization	23.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)
81: 191st Street & Driveway B
AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	180	140	170	30	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	196	152	185	33	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	337				462	245
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	337				462	245
tC, single (s)	4.5				6.8	6.8
tC, 2 stage (s)						
tF (s)	2.6				3.8	3.8
p0 queue free %	99				93	99
cM capacity (veh/h)	1038				494	671

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	207	337	33	5
Volume Left	11	0	33	0
Volume Right	0	185	0	5
cSH	1038	1700	494	671
Volume to Capacity	0.01	0.20	0.07	0.01
Queue Length 95th (ft)	1	0	5	1
Control Delay (s)	0.5	0.0	12.8	10.4
Lane LOS	A		B	B
Approach Delay (s)	0.5	0.0	12.5	
Approach LOS			B	

Intersection Summary			
Average Delay	1.0		
Intersection Capacity Utilization	27.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)
82: Driveway C & Waverly Road
AM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	60	50	50	190	180	50
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	65	54	54	207	196	54
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	538	223	250			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	538	223	250			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	87	93	96			
cM capacity (veh/h)	487	822	1327			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	65	54	261	250
Volume Left	65	0	54	0
Volume Right	0	54	0	54
cSH	487	822	1327	1700
Volume to Capacity	0.13	0.07	0.04	0.15
Queue Length 95th (ft)	12	5	3	0
Control Delay (s)	13.5	9.7	1.9	0.0
Lane LOS	B	A	A	
Approach Delay (s)	11.8		1.9	0.0
Approach LOS	B			

Intersection Summary			
Average Delay	3.0		
Intersection Capacity Utilization	38.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)
83: Driveway D & Waverly Road
AM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	20	10	90	370	380	110
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	22	11	98	402	413	120
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	870	266	533			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	870	266	533			
tC, single (s)	7.6	7.1	4.1			
tC, 2 stage (s)						
tF (s)	3.9	3.4	2.2			
p0 queue free %	89	98	91			
cM capacity (veh/h)	206	708	1038			

Direction, Lane #	EB 1	EB 2	NB 1	NB 2	SB 1	SB 2
Volume Total	22	11	232	268	275	257
Volume Left	22	0	98	0	0	0
Volume Right	0	11	0	0	0	120
cSH	206	708	1038	1700	1700	1700
Volume to Capacity	0.11	0.02	0.09	0.16	0.16	0.15
Queue Length 95th (ft)	9	1	8	0	0	0
Control Delay (s)	24.5	10.2	4.2	0.0	0.0	0.0
Lane LOS	C	B	A			
Approach Delay (s)	19.7		2.0		0.0	
Approach LOS	C					

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	40.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)
84: 191st Street & Driveway E — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	80	30	20	20	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	87	33	22	22	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	54				152	43
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	54				152	43
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				97	99
cM capacity (veh/h)	1564				838	1033

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	98	54	27
Volume Left	11	0	22
Volume Right	0	22	5
cSH	1564	1700	871
Volume to Capacity	0.01	0.03	0.03
Queue Length 95th (ft)	1	0	2
Control Delay (s)	0.9	0.0	9.3
Lane LOS	A		A
Approach Delay (s)	0.9	0.0	9.3
Approach LOS			A

Intersection Summary			
Average Delay	1.9		
Intersection Capacity Utilization	21.4%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner IMF Operations + Induced Development - (Improved + Mitigated) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)
1: 175th Street & Waverly Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	10	390	10	20	30	690	280	10	10	160	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.91		1.00	0.99		1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1659		1805	1819		1770	3523		1805	3426	
Flt Permitted	0.72	1.00		0.38	1.00		0.62	1.00		0.57	1.00	
Satd. Flow (perm)	1346	1659		724	1819		1155	3523		1074	3426	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	53	11	411	11	21	32	726	295	11	11	168	42
RTOR Reduction (vph)	0	363	0	0	28	0	0	2	0	0	16	0
Lane Group Flow (vph)	53	59	0	11	25	0	726	304	0	11	194	0
Heavy Vehicles (%)	2%	0%	3%	0%	0%	0%	2%	2%	0%	0%	2%	3%
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	10.5	10.5		10.5	10.5		69.5	61.4		46.9	43.8	
Effective Green, g (s)	10.5	10.5		10.5	10.5		69.5	61.4		46.9	43.8	
Actuated g/C Ratio	0.12	0.12		0.12	0.12		0.77	0.68		0.52	0.49	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	157	194		84	212		1033	2403		585	1667	
v/s Ratio Prot		0.04			0.01		c0.16	0.09		0.00	0.06	
v/s Ratio Perm	c0.04			0.02			c0.38			0.01		
v/c Ratio	0.34	0.30		0.13	0.12		0.70	0.13		0.02	0.12	
Uniform Delay, d1	36.6	36.4		35.7	35.6		6.3	5.0		10.4	12.6	
Progression Factor	1.00	1.00		1.00	1.00		0.51	0.88		1.00	1.00	
Incremental Delay, d2	1.3	0.9		0.7	0.2		1.8	0.1		0.0	0.1	
Delay (s)	37.8	37.3		36.4	35.8		5.0	4.5		10.4	12.7	
Level of Service	D	D		D	D		A	A		B	B	
Approach Delay (s)		37.4			35.9			4.9			12.6	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM Average Control Delay	15.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	79.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)
2: US 56 & Gardner Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	180	490	50	320	920	400	50	860	220	320	910	150
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3519	1583	1770	3654	1583	1770	3689	1568	3400	3435	
Flt Permitted	0.16	1.00	1.00	0.35	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	297	3519	1583	649	3654	1583	1770	3689	1568	3400	3435	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	189	516	53	337	968	421	53	905	232	337	958	158
RTOR Reduction (vph)	0	0	38	0	0	233	0	0	156	0	14	0
Lane Group Flow (vph)	189	516	15	337	968	188	53	905	76	337	1102	0
Heavy Vehicles (%)	2%	8%	2%	2%	4%	2%	2%	3%	3%	3%	3%	2%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			
Actuated Green, G (s)	32.3	25.1	25.1	33.7	25.8	25.8	3.9	29.0	29.0	11.3	36.4	
Effective Green, g (s)	32.3	25.1	25.1	33.7	25.8	25.8	3.9	29.0	29.0	11.3	36.4	
Actuated g/C Ratio	0.36	0.28	0.28	0.37	0.29	0.29	0.04	0.32	0.32	0.13	0.40	
Clearance Time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	224	981	441	341	1047	454	77	1189	505	427	1389	
v/s Ratio Prot	0.07	0.15		c0.09	0.26		c0.03	0.25		0.10	c0.32	
v/s Ratio Perm	0.23		0.01	c0.28		0.12			0.05			
v/c Ratio	0.84	0.53	0.03	0.99	0.92	0.42	0.69	0.76	0.15	0.79	0.79	
Uniform Delay, d1	23.0	27.4	23.6	25.9	31.2	26.0	42.5	27.4	21.7	38.2	23.5	
Progression Factor	1.34	0.66	0.39	1.33	1.15	1.93	0.74	0.56	0.30	1.00	1.00	
Incremental Delay, d2	23.6	2.0	0.1	37.1	11.0	1.9	14.2	1.8	0.1	9.4	3.2	
Delay (s)	54.4	20.0	9.4	71.6	46.9	52.1	45.5	17.1	6.7	47.6	26.7	
Level of Service	D	C	A	E	D	D	D	B	A	D	C	
Approach Delay (s)		27.8			53.0			16.3			31.5	
Approach LOS		C			D			B			C	

Intersection Summary			
HCM Average Control Delay	34.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	13.3
Intersection Capacity Utilization	83.8%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)
3: US 56 & Elm — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	1020	30	40	1640	40	20	10	50	100	20	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			1.00		1.00	0.88		1.00	0.91	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3425			3489		1719	1637		1770	1697	
Flt Permitted		0.93			0.89		0.72	1.00		0.72	1.00	
Satd. Flow (perm)		3176			3120		1307	1637		1332	1697	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	11	1074	32	42	1726	42	21	11	53	105	21	32
RTOR Reduction (vph)	0	1	0	0	1	0	0	47	0	0	24	0
Lane Group Flow (vph)	0	1116	0	0	1809	0	21	17	0	105	29	0
Heavy Vehicles (%)	0%	5%	3%	3%	3%	3%	5%	0%	2%	2%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		70.0			70.0		11.0	11.0		11.0	11.0	
Effective Green, g (s)		70.0			70.0		11.0	11.0		11.0	11.0	
Actuated g/C Ratio		0.78			0.78		0.12	0.12		0.12	0.12	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2470			2427		160	200		163	207	
v/s Ratio Prot								0.01			0.02	
v/s Ratio Perm		0.35			c0.58		0.02			c0.08		
v/c Ratio		0.45			0.75		0.13	0.09		0.64	0.14	
Uniform Delay, d1		3.4			5.3		35.2	35.0		37.6	35.3	
Progression Factor		0.44			1.23		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.5			1.5		0.4	0.2		8.4	0.3	
Delay (s)		2.0			8.0		35.6	35.2		46.1	35.6	
Level of Service		A			A		D	D		D	D	
Approach Delay (s)		2.0			8.0			35.3			42.6	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	8.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	95.1%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)
4: US 56 & Mulberry — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	1150	10	30	1750	40	10	5	20	40	10	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			1.00		1.00	0.88		1.00	0.90	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3435			3490		1805	1605		1752	1713	
Flt Permitted		0.89			0.91		0.74	1.00		0.74	1.00	
Satd. Flow (perm)		3045			3176		1399	1605		1366	1713	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	1211	11	32	1842	42	11	5	21	42	11	21
RTOR Reduction (vph)	0	1	0	0	1	0	0	19	0	0	19	0
Lane Group Flow (vph)	0	1242	0	0	1915	0	11	7	0	42	13	0
Heavy Vehicles (%)	0%	5%	0%	3%	3%	3%	0%	0%	5%	3%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		73.8			73.8		7.2	7.2		7.2	7.2	
Effective Green, g (s)		73.8			73.8		7.2	7.2		7.2	7.2	
Actuated g/C Ratio		0.82			0.82		0.08	0.08		0.08	0.08	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2497			2604		112	128		109	137	
v/s Ratio Prot								0.00			0.01	
v/s Ratio Perm		0.41			c0.60		0.01			c0.03		
v/c Ratio		0.50			0.74		0.10	0.05		0.39	0.09	
Uniform Delay, d1		2.5			3.7		38.4	38.2		39.3	38.4	
Progression Factor		0.38			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.7			1.1		0.4	0.2		2.3	0.3	
Delay (s)		1.6			4.8		38.8	38.4		41.6	38.7	
Level of Service		A			A		D	D		D	D	
Approach Delay (s)		1.6			4.8			38.5			40.3	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	4.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	87.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner IMF Operations + Induced Development - (Improved + Mitigated) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

5: US 56 & Moonlight Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	150	800	250	380	1510	1280	200	550	160	730	720	180
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1736	3585	1583	1770	3689	1583	1770	3725	1583	3433	3539	1553
Flt Permitted	0.10	1.00	1.00	0.16	1.00	1.00	0.28	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	177	3585	1583	296	3689	1583	514	3725	1583	3433	3539	1553
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	158	842	263	400	1589	1347	211	579	168	768	758	189
RTOR Reduction (vph)	0	0	119	0	0	227	0	0	116	0	0	93
Lane Group Flow (vph)	158	842	144	400	1589	1120	211	579	52	768	758	96
Heavy Vehicles (%)	4%	6%	2%	2%	3%	2%	2%	2%	2%	2%	2%	4%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		custom	Prot		Perm
Protected Phases	5	2		1	6		3	8	8	7	4	
Permitted Phases	2		2	6		6	8		8			4
Actuated Green, G (s)	47.4	41.4	41.4	69.5	58.0	58.0	23.0	14.5	14.5	18.5	24.5	24.5
Effective Green, g (s)	47.4	41.4	41.4	69.5	58.0	58.0	23.0	14.5	14.5	18.5	24.5	24.5
Actuated g/C Ratio	0.39	0.34	0.34	0.58	0.48	0.48	0.19	0.12	0.12	0.15	0.20	0.20
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	148	1237	546	449	1783	765	187	450	191	529	723	317
v/s Ratio Prot	0.05	0.23		c0.17	0.43		0.08	c0.16	0.03	c0.22	0.21	
v/s Ratio Perm	0.37		0.09	0.35		c0.71	0.14					0.06
v/c Ratio	1.07	0.68	0.26	0.89	0.89	1.46	1.13	1.29	0.27	1.45	1.05	0.30
Uniform Delay, d1	31.8	33.6	28.3	26.5	28.1	31.0	46.8	52.8	48.0	50.7	47.8	40.5
Progression Factor	1.00	1.00	1.00	0.92	0.96	0.97	0.90	0.89	0.77	1.00	1.00	1.00
Incremental Delay, d2	93.1	3.0	1.2	5.8	2.0	210.8	101.2	143.5	0.3	213.7	46.9	0.2
Delay (s)	124.9	36.7	29.5	30.1	29.0	240.9	143.1	190.6	37.2	264.5	94.6	40.7
Level of Service	F	D	C	C	C	F	F	F	D	F	F	D
Approach Delay (s)		46.2			114.7			153.2			164.7	
Approach LOS		D			F			F			F	

Intersection Summary			
HCM Average Control Delay	119.7	HCM Level of Service	F
HCM Volume to Capacity ratio	1.43		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	116.6%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

6: Old US 56 & US 56

PM Peak Hour

Movement	NBL	NBR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	730	150	1380	310	10	2440
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	0.97	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	3433	1599	3654	1568	1805	3725
Flt Permitted	0.95	1.00	1.00	1.00	0.11	1.00
Satd. Flow (perm)	3433	1599	3654	1568	213	3725
Peak-hour factor, PHF	0.97	0.97	0.95	0.95	0.95	0.95
Adj. Flow (vph)	753	155	1453	326	11	2568
RTOR Reduction (vph)	0	78	0	43	0	0
Lane Group Flow (vph)	753	78	1453	283	11	2568
Heavy Vehicles (%)	2%	1%	4%	3%	0%	2%
Turn Type		Perm		pm+ov	pm+pt	
Protected Phases	8		2	8	1	6
Permitted Phases		8	2	2	6	6
Actuated Green, G (s)	27.0	27.0	77.2	104.2	83.0	83.0
Effective Green, g (s)	27.0	27.0	77.2	104.2	83.0	83.0
Actuated g/C Ratio	0.22	0.22	0.64	0.87	0.69	0.69
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	772	360	2351	1427	158	2576
v/s Ratio Prot	c0.22		0.40	0.04	0.00	c0.69
v/s Ratio Perm		0.05		0.14	0.05	
v/c Ratio	0.98	0.22	0.62	0.20	0.07	1.00
Uniform Delay, d1	46.2	37.9	12.7	1.3	10.0	18.4
Progression Factor	1.00	1.00	0.19	0.91	0.97	0.52
Incremental Delay, d2	26.2	0.3	0.1	0.0	0.1	13.1
Delay (s)	72.3	38.2	2.5	1.2	9.8	22.7
Level of Service	E	D	A	A	A	C
Approach Delay (s)	66.5		2.3			22.6
Approach LOS	E		A			C

Intersection Summary			
HCM Average Control Delay	23.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	93.2%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

7: US-56 & Cedar Niles

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	60	2110	190	780	1990	60	210	20	860	60	20	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2	5.2	5.2	5.2	5.2
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00	1.00	1.00	0.88	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3689	1583	3433	3689	1583	1770	2000	2787	1770	2000	1568
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.74	1.00	1.00	0.74	1.00	1.00
Satd. Flow (perm)	1770	3689	1583	3433	3689	1583	1385	2000	2787	1385	2000	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	63	2221	200	821	2095	63	221	21	905	63	21	42
RTOR Reduction (vph)	0	0	77	0	0	18	0	0	0	0	0	38
Lane Group Flow (vph)	63	2221	123	821	2095	45	221	21	905	63	21	4
Heavy Vehicles (%)	2%	3%	2%	2%	3%	2%	2%	0%	2%	2%	0%	3%
Turn Type	Prot		Perm	Prot		Perm	Perm		pt+ov	Perm		Perm
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases			2			6	8			4		4
Actuated Green, G (s)	5.6	68.8	68.8	23.0	86.2	86.2	12.6	12.6	40.8	12.6	12.6	12.6
Effective Green, g (s)	5.6	68.8	68.8	23.0	86.2	86.2	12.6	12.6	40.8	12.6	12.6	12.6
Actuated g/C Ratio	0.05	0.57	0.57	0.19	0.72	0.72	0.10	0.10	0.34	0.10	0.10	0.10
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2		5.2	5.2	5.2
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lane Grp Cap (vph)	83	2115	908	658	2650	1137	145	210	948	145	210	165
v/s Ratio Prot	0.04	c0.60		c0.24	0.57			0.01	0.32		0.01	
v/s Ratio Perm			0.08			0.03	c0.16			0.05		0.00
v/c Ratio	0.76	1.05	0.14	1.25	0.79	0.04	1.52	0.10	0.95	0.43	0.10	0.03
Uniform Delay, d1	56.5	25.6	11.8	48.5	11.0	4.9	53.7	48.6	38.7	50.4	48.6	48.2
Progression Factor	0.83	0.60	0.08	1.08	1.01	1.07	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	27.8	33.8	0.3	112.7	0.2	0.0	267.7	0.1	18.9	0.8	0.1	0.0
Delay (s)	74.9	49.1	1.2	164.9	11.4	5.3	321.4	48.6	57.6	51.1	48.6	48.2
Level of Service	E	D	A	F	B	A	F	D	E	D	D	D
Approach Delay (s)		45.9			53.6			108.2			49.7	
Approach LOS		D			D			F			D	

Intersection Summary			
HCM Average Control Delay	60.0	HCM Level of Service	E
HCM Volume to Capacity ratio	1.15		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.6
Intersection Capacity Utilization	109.0%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

8: US-56 & I-35 SB Ramps

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	2720	280	650	1250	0	0	0	0	150	0	1550
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		0.99		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3486		1736	3725					1770		2760
Flt Permitted		1.00		0.23	1.00					0.95		1.00
Satd. Flow (perm)		3486		418	3725					1770		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2863	295	684	1316	0	0	0	0	158	0	1632
RTOR Reduction (vph)	0	7	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	3152	0	684	1316	0	0	0	0	158	0	1632
Heavy Vehicles (%)	0%	2%	3%	4%	2%	0%	0%	0%	0%	2%	0%	3%
Turn Type				pm+pt						custom		custom
Protected Phases		2		1	6					4		5
Permitted Phases				6						4		4
Actuated Green, G (s)		68.0		44.5	44.5					10.0		60.5
Effective Green, g (s)		68.0		44.5	44.5					10.0		60.5
Actuated g/C Ratio		0.57		0.37	0.37					0.08		0.50
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		1975		452	1381					148		1507
v/s Ratio Prot		c0.90		c0.34	0.35					0.09		c0.46
v/s Ratio Perm				0.22								0.14
v/c Ratio		1.60		1.51	0.95					1.07		1.08
Uniform Delay, d1		26.0		34.3	36.7					55.0		29.8
Progression Factor		0.76		0.94	0.90					1.00		1.00
Incremental Delay, d2		268.3		238.7	10.9					93.1		49.2
Delay (s)		288.0		270.8	43.9					148.1		78.9
Level of Service		F		F	D					F		E
Approach Delay (s)		288.0			121.5			0.0			85.0	
Approach LOS		F			F			A			F	

Intersection Summary			
HCM Average Control Delay	187.8	HCM Level of Service	F
HCM Volume to Capacity ratio	1.49		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	140.1%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

9: US-56 & I-35 NB Ramps — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1550	0	0	1800	570	100	0	400	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95	0.95			
Frt		1.00			1.00	0.85	1.00	0.85	0.85			
Flt Protected		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (prot)		3725			3539	1538	1703	1408	1408			
Flt Permitted		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (perm)		3725			3539	1538	1703	1408	1408			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1632	0	0	1895	600	105	0	421	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	82	0	0	0	0	0	0
Lane Group Flow (vph)	0	1632	0	0	1895	518	105	211	210	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	5%	6%	0%	9%	0%	0%	0%
Turn Type						Perm	Perm		Perm			
Protected Phases		2			6			8				
Permitted Phases						6	8		8			
Actuated Green, G (s)		86.2			86.2	86.2	23.8	23.8	23.8			
Effective Green, g (s)		86.2			86.2	86.2	23.8	23.8	23.8			
Actuated g/C Ratio		0.72			0.72	0.72	0.20	0.20	0.20			
Clearance Time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0	3.0			
Lane Grp Cap (vph)		2676			2542	1105	338	279	279			
v/s Ratio Prot		0.44			c0.54			c0.15				
v/s Ratio Perm						0.34	0.06		0.15			
v/c Ratio		0.61			0.75	0.47	0.31	0.76	0.75			
Uniform Delay, d1		8.5			10.2	7.2	41.1	45.4	45.3			
Progression Factor		0.38			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2		0.1			1.2	0.3	0.5	11.1	10.9			
Delay (s)		3.3			11.5	7.5	41.6	56.5	56.2			
Level of Service		A			B	A	D	E	E			
Approach Delay (s)		3.3			10.5			53.4			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	12.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	85.1%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

10: Santa Fe & Moonlight Road — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	240	480	440	160	380	940
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.96		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3398		1770	3539
Flt Permitted	0.95	1.00	1.00		0.38	1.00
Satd. Flow (perm)	1770	1583	3398		700	3539
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	253	505	463	168	400	989
RTOR Reduction (vph)	0	407	18	0	0	0
Lane Group Flow (vph)	253	98	613	0	400	989
Turn Type		Perm			pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8			6	
Actuated Green, G (s)	23.2	23.2	68.9		86.8	86.8
Effective Green, g (s)	23.2	23.2	68.9		86.8	86.8
Actuated g/C Ratio	0.19	0.19	0.57		0.72	0.72
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	342	306	1951		621	2560
v/s Ratio Prot	c0.14		0.18		c0.07	0.28
v/s Ratio Perm		0.06			c0.40	
v/c Ratio	0.74	0.32	0.31		0.64	0.39
Uniform Delay, d1	45.6	41.6	13.3		13.7	6.4
Progression Factor	1.00	1.00	1.00		1.27	1.65
Incremental Delay, d2	8.1	0.6	0.4		1.1	0.2
Delay (s)	53.7	42.2	13.7		18.6	10.7
Level of Service	D	D	B		B	B
Approach Delay (s)	46.0		13.7			13.0
Approach LOS	D		B			B

Intersection Summary			
HCM Average Control Delay	22.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

11: Waverly Road & US 56 — PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	20	330	170	300	230	30	40	90	20	180	150	600
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95		1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.98		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1805	3539	1524	3400	3457		1752	3167	1615	1671	3374	1568
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1805	3539	1524	3400	3457		1752	3167	1615	1671	3374	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	347	179	316	242	32	42	95	21	189	158	632
RTOR Reduction (vph)	0	0	151	0	13	0	0	0	17	0	0	393
Lane Group Flow (vph)	21	347	28	316	261	0	42	95	4	189	158	239
Heavy Vehicles (%)	0%	2%	6%	3%	2%	7%	3%	14%	0%	8%	7%	3%
Turn Type	Prot		Perm	Prot			Prot		Perm	Prot		Perm
Protected Phases	3	8		7	4		5	2		1	6	
Permitted Phases			8					2	2			6
Actuated Green, G (s)	2.2	14.0	14.0	16.6	28.4		5.3	16.5	16.5	22.9	34.1	34.1
Effective Green, g (s)	2.2	14.0	14.0	16.6	28.4		5.3	16.5	16.5	22.9	34.1	34.1
Actuated g/C Ratio	0.02	0.16	0.16	0.18	0.32		0.06	0.18	0.18	0.25	0.38	0.38
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	44	551	237	627	1091		103	581	296	425	1278	594
v/s Ratio Prot	0.01	c0.10		c0.09	0.08		0.02	0.03		c0.11	0.05	
v/s Ratio Perm			0.02						0.00			c0.15
v/c Ratio	0.48	0.63	0.12	0.50	0.24		0.41	0.16	0.01	0.44	0.12	0.40
Uniform Delay, d1	43.3	35.6	32.7	33.0	22.8		40.8	30.9	30.1	28.2	18.2	20.5
Progression Factor	1.00	1.00	1.00	0.89	0.85		0.93	0.96	0.96	1.58	0.35	2.27
Incremental Delay, d2	7.9	2.3	0.2	0.6	0.1		2.6	0.6	0.1	0.4	0.1	1.0
Delay (s)	51.3	37.8	32.9	29.9	19.5		40.7	30.4	29.1	44.9	6.4	47.4
Level of Service	D	D	C	C	B		D	C	C	D	A	D
Approach Delay (s)		36.7			25.1			32.9			40.3	
Approach LOS		D			C			C			D	

Intersection Summary			
HCM Average Control Delay	35.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	62.1%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

12: 183rd Street & Four Corners Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	50	5	0	30	5	5	50	0	5	20	5
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	53	5	0	32	5	5	53	0	5	21	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	63	37	58	32
Volume Left (vph)	5	0	5	5
Volume Right (vph)	5	5	0	5
Hadj (s)	0.00	-0.04	0.05	-0.01
Departure Headway (s)	4.1	4.1	4.2	4.2
Degree Utilization, x	0.07	0.04	0.07	0.04
Capacity (veh/h)	848	849	827	838
Control Delay (s)	7.5	7.3	7.5	7.3
Approach Delay (s)	7.5	7.3	7.5	7.3
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.4		
HCM Level of Service	A		
Intersection Capacity Utilization	17.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

13: 183rd Street & US 56 — PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	50	0	0	120	160	30
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	53	0	0	126	168	32
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	311	184	200			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	311	184	200			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	92	100	100			
cM capacity (veh/h)	682	863	1384			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	53	126	200
Volume Left	53	0	0
Volume Right	0	0	32
cSH	682	1384	1700
Volume to Capacity	0.08	0.00	0.12
Queue Length 95th (ft)	6	0	0
Control Delay (s)	10.7	0.0	0.0
Lane LOS	B		
Approach Delay (s)	10.7	0.0	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	20.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

14: 183rd Street & Waverly Road — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	10	280	190	10	190	230
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	11	295	200	11	200	242
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	847	205			211	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	847	205			211	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	96	65			85	
cM capacity (veh/h)	286	840			1372	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	305	211	442
Volume Left	11	0	200
Volume Right	295	11	0
cSH	788	1700	1372
Volume to Capacity	0.39	0.12	0.15
Queue Length 95th (ft)	46	0	13
Control Delay (s)	12.4	0.0	4.4
Lane LOS	B		A
Approach Delay (s)	12.4	0.0	4.4
Approach LOS	B		

Intersection Summary			
Average Delay	6.0		
Intersection Capacity Utilization	61.1%	ICU Level of Service	B
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

15: 183rd Street & Gardner Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	130	140	170	170	140	90	220	950	280	130	940	120
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.92		1.00	0.94		1.00	0.97		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1726		1770	1764		1805	3393		1770	3449	
Flt Permitted	0.52	1.00		0.21	1.00		0.18	1.00		0.11	1.00	
Satd. Flow (perm)	964	1726		384	1764		350	3393		213	3449	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	147	179	179	147	95	232	1000	295	137	989	126
RTOR Reduction (vph)	0	49	0	0	0	0	0	31	0	0	11	0
Lane Group Flow (vph)	137	277	0	179	242	0	232	1264	0	137	1104	0
Heavy Vehicles (%)	2%	1%	1%	2%	1%	2%	0%	3%	2%	2%	3%	2%
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	21.8	15.8		29.0	19.4		40.0	40.0		39.6	39.6	
Effective Green, g (s)	21.8	15.8		29.0	19.4		40.0	40.0		39.6	39.6	
Actuated g/C Ratio	0.24	0.18		0.32	0.22		0.44	0.44		0.44	0.44	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	287	303		272	380		236	1508		173	1518	
v/s Ratio Prot	0.03	c0.16		c0.07	0.14		0.05	c0.37		0.04	c0.32	
v/s Ratio Perm	0.08			0.14			c0.38			0.31		
v/c Ratio	0.48	0.92		0.66	0.64		0.98	0.84		0.79	0.73	
Uniform Delay, d1	28.0	36.4		24.4	32.1		29.2	22.1		20.9	20.8	
Progression Factor	1.15	1.09		1.00	1.00		1.00	1.00		0.80	0.85	
Incremental Delay, d2	1.3	30.5		5.7	3.5		53.5	5.7		13.4	1.8	
Delay (s)	33.6	70.4		30.0	35.6		82.7	27.9		30.1	19.5	
Level of Service	C	E		C	D		F	C		C	B	
Approach Delay (s)		59.5			33.2			36.2			20.6	
Approach LOS		E			C			D			C	

Intersection Summary			
HCM Average Control Delay	33.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	25.0
Intersection Capacity Utilization	86.3%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

16: Four Corners Road & US 56 — PM Peak Hour

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	0	20	50	130	160	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	0	21	53	137	168	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	411	168	168			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	411	168	168			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	98	96			
cM capacity (veh/h)	579	881	1409			

Direction, Lane #	SB 1	NE 1	SW 1
Volume Total	21	189	168
Volume Left	0	53	0
Volume Right	21	0	0
cSH	881	1409	1700
Volume to Capacity	0.02	0.04	0.10
Queue Length 95th (ft)	2	3	0
Control Delay (s)	9.2	2.4	0.0
Lane LOS	A	A	
Approach Delay (s)	9.2	2.4	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	31.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)
17: 191st Street & US 56 — PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	50	5	5	120	170	30
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	53	5	5	126	179	32
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	332	195	211			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	332	195	211			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	92	99	100			
cM capacity (veh/h)	661	852	1372			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	58	132	211
Volume Left	53	5	0
Volume Right	5	0	32
cSH	674	1372	1700
Volume to Capacity	0.09	0.00	0.12
Queue Length 95th (ft)	7	0	0
Control Delay (s)	10.8	0.3	0.0
Lane LOS	B	A	
Approach Delay (s)	10.8	0.3	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	20.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)
18: 191st Street & Four Corners Road — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	20	30	120	40	20	120
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.95	0.92	0.92	0.95
Hourly flow rate (vph)	22	33	126	43	22	126
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			54		334	38
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			54		334	38
tC, single (s)			5.0		6.7	7.2
tC, 2 stage (s)						
tF (s)			3.0		3.8	4.2
p0 queue free %			89		96	84
cM capacity (veh/h)			1124		532	812

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	54	170	148
Volume Left	0	126	22
Volume Right	33	0	126
cSH	1700	1124	754
Volume to Capacity	0.03	0.11	0.20
Queue Length 95th (ft)	0	9	18
Control Delay (s)	0.0	6.7	10.9
Lane LOS		A	B
Approach Delay (s)	0.0	6.7	10.9
Approach LOS			B

Intersection Summary			
Average Delay	7.4		
Intersection Capacity Utilization	30.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)
19: 191st Street & Waverly Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	130	120	70	30	130	20	90	50	10	20	100	120
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	137	126	74	32	137	21	95	53	11	21	105	126
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	158			200			826	658	163	684	684	147
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	158			200			826	658	163	684	684	147
tC, single (s)	4.1			4.1			8.0	6.5	6.2	7.1	6.5	6.3
tC, 2 stage (s)												
tF (s)	2.2			2.2			4.3	4.0	3.3	3.5	4.0	3.4
p0 queue free %	90			98			23	84	99	93	68	86
cM capacity (veh/h)	1404			1366			124	339	887	290	328	886

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	337	189	158	253
Volume Left	137	32	95	21
Volume Right	74	21	11	126
cSH	1404	1366	169	472
Volume to Capacity	0.10	0.02	0.93	0.54
Queue Length 95th (ft)	8	2	176	78
Control Delay (s)	3.7	1.4	107.2	21.1
Lane LOS	A	A	F	C
Approach Delay (s)	3.7	1.4	107.2	21.1
Approach LOS			F	C

Intersection Summary			
Average Delay	25.4		
Intersection Capacity Utilization	62.8%	ICU Level of Service	B
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)
20: W 188th Street & Gardner Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	110	30	310	270	30	290	280	1410	240	240	1120	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	5.0	5.0	5.0	2.5	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.86		1.00	0.98		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1770	1845	1583	1770	1608		1770	3582		1770	3689	1524
Flt Permitted	0.29	1.00	1.00	0.72	1.00		0.12	1.00		0.08	1.00	1.00
Satd. Flow (perm)	548	1845	1583	1341	1608		222	3582		141	3689	1524
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	116	33	326	293	33	315	295	1484	261	261	1179	105
RTOR Reduction (vph)	0	0	260	0	206	0	0	13	0	0	0	48
Lane Group Flow (vph)	116	33	66	293	142	0	295	1732	0	261	1179	57
Heavy Vehicles (%)	2%	3%	2%	2%	3%	2%	2%	4%	2%	2%	3%	6%
Turn Type	pm+pt		Perm	pm+pt			pm+pt			pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	19.3	13.6	13.6	22.4	13.9		73.6	56.1		67.2	52.9	52.9
Effective Green, g (s)	19.3	13.6	13.6	22.4	13.9		73.6	56.1		67.2	52.9	52.9
Actuated g/C Ratio	0.18	0.12	0.12	0.20	0.13		0.67	0.51		0.61	0.48	0.48
Clearance Time (s)	5.0	5.0	5.0	2.5	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	159	228	196	306	203		395	1827		298	1774	733
v/s Ratio Prot	0.04	0.02		c0.07	0.09		c0.12	c0.48		0.11	0.32	
v/s Ratio Perm	0.09		0.04	c0.12			0.38			0.42		0.04
v/c Ratio	0.73	0.14	0.34	0.96	0.70		0.75	0.95		0.88	0.66	0.08
Uniform Delay, d1	41.3	43.0	44.1	42.6	46.0		21.9	25.6		33.4	21.8	15.4
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.15	0.77		1.00	1.00	1.00
Incremental Delay, d2	15.4	0.3	1.0	39.7	10.0		5.4	9.2		23.7	1.0	0.0
Delay (s)	56.7	43.3	45.1	82.3	56.1		30.7	28.8		57.1	22.7	15.4
Level of Service	E	D	D	F	E		C	C		E	C	B
Approach Delay (s)		47.8			68.1			29.1			28.0	
Approach LOS		D			E			C			C	

Intersection Summary			
HCM Average Control Delay	35.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	99.8%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner IMF Operations + Induced Development - (Improved + Mitigated) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

21: I-35 SB Ramps & Gardner Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	380	0	1190	30	740	0	0	1310	390
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)				5.0	5.0	2.5	2.5	5.0			5.0	
Lane Util. Factor				1.00	0.95	0.95	1.00	0.95			0.95	
Frt				1.00	0.85	0.85	1.00	1.00			0.97	
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1752	1475	1475	1687	3725			3562	
Flt Permitted				0.95	1.00	1.00	0.12	1.00			1.00	
Satd. Flow (perm)				1752	1475	1475	205	3725			3562	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	400	0	1253	32	779	0	0	1379	411
RTOR Reduction (vph)	0	0	0	0	386	14	0	0	0	0	23	0
Lane Group Flow (vph)	0	0	0	400	241	612	32	779	0	0	1767	0
Heavy Vehicles (%)	0%	0%	0%	3%	0%	4%	7%	2%	0%	0%	3%	3%
Turn Type				custom		custom	pm+pt					
Protected Phases				8	8	1	5	2			6	
Permitted Phases				8		8	2					
Actuated Green, G (s)				28.9	28.9	62.9	37.9	34.6			65.3	
Effective Green, g (s)				28.9	28.9	62.9	37.9	34.6			65.3	
Actuated g/C Ratio				0.26	0.26	0.57	0.34	0.31			0.59	
Clearance Time (s)				5.0	5.0	2.5	2.5	5.0			5.0	
Vehicle Extension (s)				3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)				460	388	877	115	1172			2115	
v/s Ratio Prot				c0.23	0.16	c0.22	0.01	0.21			c0.50	
v/s Ratio Perm						0.20	0.09					
v/c Ratio				0.87	0.62	0.70	0.28	0.66			0.84	
Uniform Delay, d1				38.7	35.7	16.8	48.8	32.7			18.0	
Progression Factor				1.00	1.00	1.00	1.36	0.56			0.57	
Incremental Delay, d2				15.9	3.1	2.4	0.8	1.9			2.9	
Delay (s)				54.7	38.8	19.2	67.3	20.3			13.2	
Level of Service				D	D	B	E	C			B	
Approach Delay (s)		0.0			35.2			22.1			13.2	
Approach LOS		A			D			C			B	

Intersection Summary			
HCM Average Control Delay	23.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	85.8%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

22: I-35 NB Ramps & Gardner Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	180	0	20	0	0	0	0	600	250	840	850	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0						5.0	5.0	5.0	5.0	
Lane Util. Factor		1.00						1.00	1.00	0.97	0.95	
Frt		0.99						1.00	0.85	1.00	1.00	
Flt Protected		0.96						1.00	1.00	0.95	1.00	
Satd. Flow (prot)		1694						1961	1568	3367	3725	
Flt Permitted		0.96						1.00	1.00	0.95	1.00	
Satd. Flow (perm)		1694						1961	1568	3367	3725	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	189	0	21	0	0	0	0	632	263	884	895	0
RTOR Reduction (vph)	0	3	0	0	0	0	0	0	152	0	0	0
Lane Group Flow (vph)	0	207	0	0	0	0	0	632	111	884	895	0
Heavy Vehicles (%)	6%	0%	5%	0%	0%	0%	0%	2%	3%	4%	2%	0%
Turn Type	Split								Perm	Prot		
Protected Phases	4	4						2		1	6	
Permitted Phases									2			
Actuated Green, G (s)		16.5						46.5	46.5	32.0	83.5	
Effective Green, g (s)		16.5						46.5	46.5	32.0	83.5	
Actuated g/C Ratio		0.15						0.42	0.42	0.29	0.76	
Clearance Time (s)		5.0						5.0	5.0	5.0	5.0	
Vehicle Extension (s)		3.0						3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)		254						829	663	979	2828	
v/s Ratio Prot		c0.12						c0.32		c0.26	0.24	
v/s Ratio Perm									0.07			
v/c Ratio		0.81						0.76	0.17	0.90	0.32	
Uniform Delay, d1		45.3						27.0	19.7	37.5	4.2	
Progression Factor		1.00						0.93	1.34	0.90	0.72	
Incremental Delay, d2		17.7						5.8	0.5	6.7	0.2	
Delay (s)		63.0						31.1	26.9	40.6	3.2	
Level of Service		E						C	C	D	A	
Approach Delay (s)		63.0			0.0			29.8			21.8	
Approach LOS		E			A			C			C	

Intersection Summary			
HCM Average Control Delay	27.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	85.8%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

23: E 191st Street & Gardner Rd — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	30	140	710	20	60	810
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		5.0			5.0
Lane Util. Factor	1.00		1.00			1.00
Frt	0.89		1.00			1.00
Flt Protected	0.99		1.00			1.00
Satd. Flow (prot)	1613		1857			1850
Flt Permitted	0.99		1.00			0.91
Satd. Flow (perm)	1613		1857			1682
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	32	147	747	21	63	853
RTOR Reduction (vph)	135	0	1	0	0	0
Lane Group Flow (vph)	44	0	767	0	0	916
Heavy Vehicles (%)	3%	4%	2%	0%	7%	2%
Turn Type					Perm	
Protected Phases	8		2			6
Permitted Phases					6	
Actuated Green, G (s)	8.9		91.1			91.1
Effective Green, g (s)	8.9		91.1			91.1
Actuated g/C Ratio	0.08		0.83			0.83
Clearance Time (s)	5.0		5.0			5.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	131		1538			1393
v/s Ratio Prot	c0.03		0.41			
v/s Ratio Perm						c0.54
v/c Ratio	0.34		0.50			0.66
Uniform Delay, d1	47.8		2.8			3.6
Progression Factor	1.00		1.00			1.23
Incremental Delay, d2	1.5		0.3			2.4
Delay (s)	49.3		3.0			6.7
Level of Service	D		A			A
Approach Delay (s)	49.3		3.0			6.7
Approach LOS	D		A			A

Intersection Summary			
HCM Average Control Delay	9.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	107.3%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

24: Sunflower Road & US 56 — PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	90	10	370	30	10	10	110	300	10	170	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.99			1.00			0.90			1.00	
Flt Protected		1.00			0.96			1.00			1.00	
Satd. Flow (prot)		1857			1764			1630			1805	
Flt Permitted		1.00			0.67			0.99			0.97	
Satd. Flow (perm)		1857			1241			1620			1763	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	95	11	389	32	11	11	116	316	11	179	5
RTOR Reduction (vph)	0	4	0	0	1	0	0	98	0	0	1	0
Lane Group Flow (vph)	0	102	0	0	431	0	0	345	0	0	194	0
Heavy Vehicles (%)	0%	1%	0%	3%	0%	0%	0%	9%	4%	0%	5%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		32.4			32.4			47.6			47.6	
Effective Green, g (s)		32.4			32.4			47.6			47.6	
Actuated g/C Ratio		0.36			0.36			0.53			0.53	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		669			447			857			932	
v/s Ratio Prot		0.05										
v/s Ratio Perm					c0.35			c0.21			0.11	
v/c Ratio		0.15			0.96			0.40			0.21	
Uniform Delay, d1		19.5			28.2			12.7			11.2	
Progression Factor		1.00			1.00			0.80			1.32	
Incremental Delay, d2		0.1			33.1			1.3			0.5	
Delay (s)		19.6			61.3			11.4			15.3	
Level of Service		B			E			B			B	
Approach Delay (s)		19.6			61.3			11.4			15.3	
Approach LOS		B			E			B			B	

Intersection Summary			
HCM Average Control Delay	31.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	65.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study | 2030 Gardner Proposed Action + Indirect Effects - (Imp)

25: US 56 & 4th Street

PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	330	130	90	460	150	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0			5.0	5.0	
Lane Util. Factor	1.00			1.00	1.00	
Frt	0.96			1.00	0.95	
Flt Protected	1.00			0.99	0.97	
Satd. Flow (prot)	1755			1833	1715	
Flt Permitted	1.00			0.85	0.97	
Satd. Flow (perm)	1755			1577	1715	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	347	137	95	484	158	95
RTOR Reduction (vph)	13	0	0	0	27	0
Lane Group Flow (vph)	471	0	0	579	226	0
Heavy Vehicles (%)	5%	2%	2%	3%	2%	2%
Turn Type			Perm			
Protected Phases	4			8	2	
Permitted Phases			8			
Actuated Green, G (s)	63.1			63.1	16.9	
Effective Green, g (s)	63.1			63.1	16.9	
Actuated g/C Ratio	0.70			0.70	0.19	
Clearance Time (s)	5.0			5.0	5.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	1230			1106	322	
v/s Ratio Prot	0.27				c0.13	
v/s Ratio Perm				c0.37		
v/c Ratio	0.38			0.52	0.70	
Uniform Delay, d1	5.5			6.4	34.2	
Progression Factor	1.00			0.50	1.00	
Incremental Delay, d2	0.9			1.2	6.8	
Delay (s)	6.4			4.4	41.0	
Level of Service	A			A	D	
Approach Delay (s)	6.4			4.4	41.0	
Approach LOS	A			A	D	

Intersection Summary			
HCM Average Control Delay	12.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	80.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study | 2030 Gardner Proposed Action + Indirect Effects - (Imp)

26: 199th Street & Four Corners Road

PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	400	420	130	140	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	11	421	442	137	147	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	579				953	511
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	579				953	511
tC, single (s)	4.5				7.2	6.5
tC, 2 stage (s)						
tF (s)	2.6				4.2	3.6
p0 queue free %	99				29	98
cM capacity (veh/h)	832				206	511

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	432	579	158
Volume Left	11	0	147
Volume Right	0	137	11
cSH	832	1700	215
Volume to Capacity	0.01	0.34	0.73
Queue Length 95th (ft)	1	0	123
Control Delay (s)	0.4	0.0	57.4
Lane LOS	A		F
Approach Delay (s)	0.4	0.0	57.4
Approach LOS			F

Intersection Summary			
Average Delay	7.9		
Intersection Capacity Utilization	45.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2030 Gardner Proposed Action + Indirect Effects - (Imp)

27: 199th Street & Gardner Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	170	20	30	210	330	10	130	30	420	200	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00		1.00		1.00	1.00	1.00
Frt	1.00	0.98		1.00	1.00	0.85		0.98		1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		1.00		0.95	1.00	1.00
Satd. Flow (prot)	1805	1805		1752	1827	1583		1798		1770	1863	1568
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.98		0.53	1.00	1.00
Satd. Flow (perm)	1805	1805		1752	1827	1583		1768		995	1863	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	179	21	32	221	347	11	137	32	442	211	32
RTOR Reduction (vph)	0	5	0	0	0	275	0	8	0	0	0	13
Lane Group Flow (vph)	21	195	0	32	221	72	0	172	0	442	211	19
Heavy Vehicles (%)	0%	4%	0%	3%	4%	2%	0%	3%	3%	2%	2%	3%
Turn Type	Prot			Prot		Perm	Perm			pm+pt		Perm
Protected Phases	5	2		1	6			8		7	4	
Permitted Phases						6	8			4		4
Actuated Green, G (s)	3.1	15.4		6.5	18.8	18.8		31.9		53.1	53.1	53.1
Effective Green, g (s)	3.1	15.4		6.5	18.8	18.8		31.9		53.1	53.1	53.1
Actuated g/C Ratio	0.03	0.17		0.07	0.21	0.21		0.35		0.59	0.59	0.59
Clearance Time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	62	309		127	382	331		627		727	1099	925
v/s Ratio Prot	0.01	c0.11		0.02	c0.12					c0.11	0.11	
v/s Ratio Perm						0.05		0.10		c0.25		0.01
v/c Ratio	0.34	0.63		0.25	0.58	0.22		0.27		0.61	0.19	0.02
Uniform Delay, d1	42.4	34.7		39.5	32.0	29.5		20.8		10.9	8.5	7.7
Progression Factor	1.14	0.98		1.00	1.00	1.00		1.00		1.00	1.00	1.00
Incremental Delay, d2	3.2	4.2		1.0	2.1	0.3		1.1		1.4	0.4	0.0
Delay (s)	51.6	38.0		40.5	34.2	29.8		21.9		12.3	8.9	7.7
Level of Service	D	D		D	C	C		C		B	A	A
Approach Delay (s)		39.3			32.0			21.9			11.1	
Approach LOS		D			C			C			B	

Intersection Summary			
HCM Average Control Delay	23.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	63.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study | 2030 Gardner Proposed Action + Indirect Effects - (Imp)

30: US-56 & I-35 NB Loop

PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	1550	1320	0	1900	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	1632	1389	0	2000	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked					0.60	
vC, conflicting volume			3021		2632	816
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			3021		2388	816
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			115		18	324

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	816	816	1389	1000	1000
Volume Left	0	0	0	0	0
Volume Right	0	0	1389	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.48	0.48	0.82	0.59	0.59
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	85.1%	ICU Level of Service	E
Analysis Period (min)	15		

2030 Gardner IMF Operations + Induced Development - (Improved + Mitigated) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

37: 199th Street & West Waverley

PM Peak Hour

Movement	EBL	EBT	WBU	WBT	WBR	SWL	SWR
Lane Configurations							
Volume (veh/h)	5	820	0	830	140	200	5
Sign Control		Free		Free		Stop	
Grade		0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	891	0	902	152	217	5
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type		TWLTL		TWLTL			
Median storage veh)		2		2			
Upstream signal (ft)				802			
pX, platoon unblocked			0.00				
vC, conflicting volume	1054		0			1880	978
vC1, stage 1 conf vol						978	
vC2, stage 2 conf vol						902	
vCu, unblocked vol	1054		0			1880	978
tC, single (s)	4.1		0.0			6.6	6.2
tC, 2 stage (s)						5.6	
tF (s)	2.2		0.0			3.7	3.3
p0 queue free %	99		0			12	98
cM capacity (veh/h)	668		0			247	306

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SW 1
Volume Total	5	891	1054	0	223
Volume Left	5	0	0	0	217
Volume Right	0	0	152	0	5
cSH	668	1700	1700	1700	248
Volume to Capacity	0.01	0.52	0.62	0.00	0.90
Queue Length 95th (ft)	1	0	0	0	193
Control Delay (s)	10.4	0.0	0.0	0.0	76.8
Lane LOS	B				F
Approach Delay (s)	0.1		0.0		76.8
Approach LOS					F

Intersection Summary			
Average Delay	7.9		
Intersection Capacity Utilization	70.2%	ICU Level of Service	C
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

38: 199th Street & IH-35 SB Ramp

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	770	240	120	170	0	0	0	0	10	0	800
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		1.00		1.00	1.00					1.00		1.00
Frt		0.97		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		1572		1752	1727					1805		1282
Flt Permitted		1.00		0.11	1.00					0.95		1.00
Satd. Flow (perm)		1572		210	1727					1805		1282
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	837	261	130	185	0	0	0	0	11	0	870
RTOR Reduction (vph)	0	9	0	0	0	0	0	0	0	0	0	656
Lane Group Flow (vph)	0	1089	0	130	185	0	0	0	0	11	0	214
Heavy Vehicles (%)	0%	21%	4%	3%	10%	0%	0%	0%	0%	0%	0%	26%
Turn Type				pm+pt						Prot		custom
Protected Phases		4		3	8					6		
Permitted Phases				8								3 6
Actuated Green, G (s)		86.0		99.0	99.0					11.0		24.0
Effective Green, g (s)		86.0		99.0	99.0					11.0		24.0
Actuated g/C Ratio		0.72		0.82	0.82					0.09		0.20
Clearance Time (s)		5.0		5.0	5.0					5.0		
Vehicle Extension (s)		3.0		3.0	3.0					3.0		
Lane Grp Cap (vph)		1127		276	1425					165		256
v/s Ratio Prot		c0.69		0.03	0.11					0.01		
v/s Ratio Perm				0.36								c0.17
v/c Ratio		0.97		0.47	0.13					0.07		0.84
Uniform Delay, d1		15.7		17.8	2.1					49.8		46.1
Progression Factor		1.00		1.00	1.00					1.00		1.00
Incremental Delay, d2		19.8		1.3	0.0					0.2		20.4
Delay (s)		35.4		19.1	2.1					50.0		66.5
Level of Service		D		B	A					D		E
Approach Delay (s)		35.4			9.1			0.0			66.3	
Approach LOS		D			A			A			E	

Intersection Summary			
HCM Average Control Delay	43.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	77.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

39: 199th Street & IH-35 NB Ramp

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	670	110	0	0	210	20	80	0	50	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0		5.0			
Lane Util. Factor	1.00	1.00			1.00		1.00		1.00			
Frt	1.00	1.00			0.99		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1456	1810			1796		1597		1583			
Flt Permitted	0.47	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	725	1810			1796		1597		1583			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	728	120	0	0	228	22	87	0	54	0	0	0
RTOR Reduction (vph)	0	0	0	0	4	0	0	0	49	0	0	0
Lane Group Flow (vph)	728	120	0	0	246	0	87	0	5	0	0	0
Heavy Vehicles (%)	24%	5%	0%	0%	5%	0%	13%	0%	2%	0%	0%	0%
Turn Type	pm+pt						custom		custom			
Protected Phases	7	4			8							
Permitted Phases	4						2		2			
Actuated Green, G (s)	71.0	71.0			22.3		9.0		9.0			
Effective Green, g (s)	71.0	71.0			22.3		9.0		9.0			
Actuated g/C Ratio	0.79	0.79			0.25		0.10		0.10			
Clearance Time (s)	5.0	5.0			5.0		5.0		5.0			
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Lane Grp Cap (vph)	927	1428			445		160		158			
v/s Ratio Prot	c0.38	0.07			0.14							
v/s Ratio Perm	c0.24						c0.05		0.00			
v/c Ratio	0.79	0.08			0.55		0.54		0.03			
Uniform Delay, d1	8.6	2.1			29.5		38.5		36.6			
Progression Factor	1.00	1.00			1.21		1.00		1.00			
Incremental Delay, d2	4.4	0.1			1.4		3.7		0.1			
Delay (s)	13.0	2.3			37.2		42.3		36.7			
Level of Service	B	A			D		D		D			
Approach Delay (s)		11.5			37.2			40.1			0.0	
Approach LOS		B			D			D			A	

Intersection Summary			
HCM Average Control Delay	19.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	77.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

40: 199th Street & East Waverley

PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	160	10	5	220	10	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	174	11	5	239	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	820					
pX, platoon unblocked						
vC, conflicting volume			185		429	179
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			185		429	179
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	99
cM capacity (veh/h)			1402		584	869

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	185	245	16
Volume Left	0	5	11
Volume Right	11	0	5
cSH	1700	1402	656
Volume to Capacity	0.11	0.00	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.2	10.6
Lane LOS		A	B
Approach Delay (s)	0.0	0.2	10.6
Approach LOS			B

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	25.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

80: 191st Street & Driveway A

PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	130	20	30	80	50	120
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	141	22	33	87	54	130
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	120				380	76
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	120				380	76
tC, single (s)	5.1				7.4	7.2
tC, 2 stage (s)						
tF (s)	3.1				4.4	4.2
p0 queue free %	86				87	83
cM capacity (veh/h)	1032				404	769

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	163	120	54	130
Volume Left	141	0	54	0
Volume Right	0	87	0	130
cSH	1032	1700	404	769
Volume to Capacity	0.14	0.07	0.13	0.17
Queue Length 95th (ft)	12	0	12	15
Control Delay (s)	8.0	0.0	15.3	10.6
Lane LOS	A		C	B
Approach Delay (s)	8.0	0.0	12.0	
Approach LOS			B	

Intersection Summary			
Average Delay	7.5		
Intersection Capacity Utilization	24.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

81: 191st Street & Driveway B

PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	160	210	130	150	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	174	228	141	163	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	370				495	299
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	370				495	299
tC, single (s)	4.5				6.5	6.6
tC, 2 stage (s)						
tF (s)	2.6				3.6	3.7
p0 queue free %	99				69	98
cM capacity (veh/h)	1008				521	659

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	185	370	163	11
Volume Left	11	0	163	0
Volume Right	0	141	0	11
cSH	1008	1700	521	659
Volume to Capacity	0.01	0.22	0.31	0.02
Queue Length 95th (ft)	1	0	33	1
Control Delay (s)	0.6	0.0	15.0	10.6
Lane LOS	A		C	B
Approach Delay (s)	0.6	0.0	14.7	
Approach LOS			B	

Intersection Summary			
Average Delay	3.7		
Intersection Capacity Utilization	34.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

82: Driveway C & Waverly Road

PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	10	10	5	190	230	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	11	5	207	250	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	470	253	255			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	470	253	255			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	99	100			
cM capacity (veh/h)	553	791	1321			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	11	11	212	255
Volume Left	11	0	5	0
Volume Right	0	11	0	5
cSH	553	791	1321	1700
Volume to Capacity	0.02	0.01	0.00	0.15
Queue Length 95th (ft)	2	1	0	0
Control Delay (s)	11.6	9.6	0.2	0.0
Lane LOS	B	A	A	
Approach Delay (s)	10.6		0.2	0.0
Approach LOS	B			

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	24.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

83: Driveway D & Waverly Road

PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	100	80	50	410	340	90
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	109	87	54	446	370	98
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	750	234	467			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	750	234	467			
tC, single (s)	6.9	6.9	4.1			
tC, 2 stage (s)						
tF (s)	3.6	3.3	2.2			
p0 queue free %	66	89	95			
cM capacity (veh/h)	324	774	1090			

Direction, Lane #	EB 1	EB 2	NB 1	NB 2	SB 1	SB 2
Volume Total	109	87	203	297	246	221
Volume Left	109	0	54	0	0	0
Volume Right	0	87	0	0	0	98
cSH	324	774	1090	1700	1700	1700
Volume to Capacity	0.34	0.11	0.05	0.17	0.14	0.13
Queue Length 95th (ft)	36	9	4	0	0	0
Control Delay (s)	21.6	10.2	2.6	0.0	0.0	0.0
Lane LOS	C	B	A			
Approach Delay (s)	16.6		1.1		0.0	
Approach LOS	C					

Intersection Summary			
Average Delay	3.2		
Intersection Capacity Utilization	40.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp)

84: 191st Street & Driveway E — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	60	110	5	5	0
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	65	120	5	5	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	125				188	122
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	125				188	122
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	100
cM capacity (veh/h)	1474				806	934

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	65	125	5
Volume Left	0	0	5
Volume Right	0	5	0
cSH	1474	1700	806
Volume to Capacity	0.00	0.07	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	0.0	9.5
Lane LOS			A
Approach Delay (s)	0.0	0.0	9.5
Approach LOS			A

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	16.1%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner IMF Operations + Induced Development - (Improved + Mitigated) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

1: 175th Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↑↱		↰	↑↑↱	
Volume (vph)	70	20	640	10	10	10	370	230	10	20	240	50
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.92		1.00	0.99		1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1736	1677		1805	1850		1770	3486		1805	3397	
Flt Permitted	0.74	1.00		0.22	1.00		0.57	1.00		0.60	1.00	
Satd. Flow (perm)	1357	1677		422	1850		1053	3486		1131	3397	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	21	674	11	11	11	389	242	11	21	253	53
RTOR Reduction (vph)	0	464	0	0	9	0	0	3	0	0	12	0
Lane Group Flow (vph)	74	231	0	11	13	0	389	250	0	21	294	0
Heavy Vehicles (%)	4%	0%	2%	0%	0%	0%	2%	3%	0%	0%	3%	6%
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	18.0	18.0		18.0	18.0		62.0	51.6		51.2	45.8	
Effective Green, g (s)	18.0	18.0		18.0	18.0		62.0	51.6		51.2	45.8	
Actuated g/C Ratio	0.20	0.20		0.20	0.20		0.69	0.57		0.57	0.51	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	271	335		84	370		815	1999		684	1729	
v/s Ratio Prot		c0.14			0.01		c0.06	0.07		0.00	0.09	
v/s Ratio Perm	0.05			0.03			c0.27			0.02		
v/c Ratio	0.27	0.69		0.13	0.04		0.48	0.13		0.03	0.17	
Uniform Delay, d1	30.5	33.4		29.6	29.0		6.9	8.8		8.5	11.9	
Progression Factor	1.00	1.00		1.00	1.00		0.83	0.44		1.00	1.00	
Incremental Delay, d2	0.5	5.8		0.7	0.0		0.4	0.1		0.0	0.2	
Delay (s)	31.0	39.2		30.3	29.0		6.2	4.0		8.5	12.1	
Level of Service	C	D		C	C		A	A		A	B	
Approach Delay (s)		38.4			29.5			5.3			11.9	
Approach LOS		D			C			A			B	

Intersection Summary			
HCM Average Control Delay	21.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	79.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

2: US 56 & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↑	↱	↰	↑↑	↱	↰↰	↑↑↱	
Volume (vph)	140	820	60	170	450	270	70	990	300	360	830	190
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.97	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1752	3585	1583	1687	3486	1553	1752	3689	1553	3367	3413	
Flt Permitted	0.40	1.00	1.00	0.16	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	746	3585	1583	279	3486	1553	1752	3689	1553	3367	3413	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	147	863	63	179	474	284	74	1042	316	379	874	200
RTOR Reduction (vph)	0	0	40	0	0	204	0	0	119	0	21	0
Lane Group Flow (vph)	147	863	23	179	474	80	74	1042	197	379	1053	0
Heavy Vehicles (%)	3%	6%	2%	7%	9%	4%	3%	3%	4%	4%	3%	2%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			
Actuated Green, G (s)	31.6	25.0	25.0	32.6	25.5	25.5	5.6	29.5	29.5	11.7	35.6	
Effective Green, g (s)	31.6	25.0	25.0	32.6	25.5	25.5	5.6	29.5	29.5	11.7	35.6	
Actuated g/C Ratio	0.35	0.28	0.28	0.36	0.28	0.28	0.06	0.33	0.33	0.13	0.40	
Clearance Time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	336	996	440	212	988	440	109	1209	509	438	1350	
v/s Ratio Prot	0.03	c0.24		c0.07	0.14		0.04	c0.28		c0.11	0.31	
v/s Ratio Perm	0.12		0.01	0.24		0.05			0.13			
v/c Ratio	0.44	0.87	0.05	0.84	0.48	0.18	0.68	0.86	0.39	0.87	0.78	
Uniform Delay, d1	20.8	30.9	23.8	22.4	26.7	24.4	41.3	28.3	23.3	38.4	23.8	
Progression Factor	0.56	0.66	0.56	1.35	1.05	2.70	0.74	0.58	0.23	1.00	1.00	
Incremental Delay, d2	0.8	9.4	0.2	24.0	1.6	0.9	10.9	4.6	0.3	16.2	2.9	
Delay (s)	12.5	29.9	13.5	54.3	29.6	66.6	41.4	21.1	5.8	54.5	26.7	
Level of Service	B	C	B	D	C	E	D	C	A	D	C	
Approach Delay (s)		26.5			45.5			18.8			34.0	
Approach LOS		C			D			B			C	

Intersection Summary			
HCM Average Control Delay	30.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	19.2
Intersection Capacity Utilization	83.6%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

3: US 56 & Elm

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱			↰↑↱		↰	↱		↰	↱	
Volume (vph)	20	1480	10	10	830	90	10	10	30	110	10	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			0.99		1.00	0.89		1.00	0.88	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3436			3313		1805	1651		1770	1610	
Flt Permitted		0.93			0.93		0.72	1.00		0.73	1.00	
Satd. Flow (perm)		3211			3082		1373	1651		1358	1610	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	1558	11	11	874	95	11	11	32	116	11	42
RTOR Reduction (vph)	0	0	0	0	6	0	0	28	0	0	37	0
Lane Group Flow (vph)	0	1590	0	0	974	0	11	15	0	116	16	0
Heavy Vehicles (%)	0%	5%	0%	0%	8%	2%	0%	0%	3%	2%	0%	5%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		69.5			69.5		11.5	11.5		11.5	11.5	
Effective Green, g (s)		69.5			69.5		11.5	11.5		11.5	11.5	
Actuated g/C Ratio		0.77			0.77		0.13	0.13		0.13	0.13	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2480			2380		175	211		174	206	
v/s Ratio Prot								0.01			0.01	
v/s Ratio Perm		c0.50			0.32		0.01			c0.09		
v/c Ratio		0.64			0.41		0.06	0.07		0.67	0.08	
Uniform Delay, d1		4.6			3.4		34.5	34.6		37.4	34.6	
Progression Factor		0.66			0.98		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.8			0.5		0.2	0.1		9.3	0.2	
Delay (s)		3.9			3.8		34.7	34.7		46.7	34.8	
Level of Service		A			A		C	C		D	C	
Approach Delay (s)		3.9			3.8			34.7			43.0	
Approach LOS		A			A			C			D	

Intersection Summary			
HCM Average Control Delay	6.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	75.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

4: US 56 & Mulberry

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱			↰↑↱		↰	↱		↰	↱	
Volume (vph)	40	1630	10	10	900	60	5	5	20	100	5	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			0.99		1.00	0.88		1.00	0.87	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3432			3341		1805	1548		1770	1612	
Flt Permitted		0.90			0.93		0.73	1.00		0.74	1.00	
Satd. Flow (perm)		3090			3096		1393	1548		1379	1612	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	42	1716	11	11	947	63	5	5	21	105	5	32
RTOR Reduction (vph)	0	0	0	0	4	0	0	19	0	0	28	0
Lane Group Flow (vph)	0	1769	0	0	1017	0	5	7	0	105	9	0
Heavy Vehicles (%)	5%	5%	0%	0%	7%	8%	0%	20%	5%	2%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		71.0			71.0		10.0	10.0		10.0	10.0	
Effective Green, g (s)		71.0			71.0		10.0	10.0		10.0	10.0	
Actuated g/C Ratio		0.79			0.79		0.11	0.11		0.11	0.11	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2438			2442		155	172		153	179	
v/s Ratio Prot								0.00			0.01	
v/s Ratio Perm		c0.57			0.33		0.00			c0.08		
v/c Ratio		0.73			0.42		0.03	0.04		0.69	0.05	
Uniform Delay, d1		4.7			3.0		35.7	35.7		38.5	35.7	
Progression Factor		0.41			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.6			0.1		0.1	0.1		12.0	0.1	
Delay (s)		3.5			3.1		35.8	35.8		50.5	35.9	
Level of Service		A			A		D	D		D	D	
Approach Delay (s)		3.5			3.1			35.8			46.7	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	5.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	93.8%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner IMF Operations + Induced Development - (Improved + Mitigated) - AM Peak Hour - Synchro Intersection LOS

5: US 56 & Moonlight Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	170	1400	190	150	700	600	150	620	270	1170	530	120
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1719	3619	1568	1770	3486	1583	1770	3725	1553	3433	3539	1553
Flt Permitted	0.20	1.00	1.00	0.10	1.00	1.00	0.44	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	363	3619	1568	196	3486	1583	825	3725	1553	3433	3539	1553
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	179	1474	200	158	737	632	158	653	284	1232	558	126
RTOR Reduction (vph)	0	0	54	0	0	341	0	0	80	0	0	84
Lane Group Flow (vph)	179	1474	146	158	737	291	158	653	204	1232	558	42
Heavy Vehicles (%)	5%	5%	3%	2%	9%	2%	2%	2%	4%	2%	2%	4%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		custom	Prot		Perm
Protected Phases	5	2		1	6		3	8	8	7	4	
Permitted Phases	2		2	6		6	8		8			4
Actuated Green, G (s)	49.9	41.0	41.0	44.1	38.1	38.1	27.9	17.5	17.5	32.5	39.6	39.6
Effective Green, g (s)	49.9	41.0	41.0	44.1	38.1	38.1	27.9	17.5	17.5	32.5	39.6	39.6
Actuated g/C Ratio	0.42	0.34	0.34	0.37	0.32	0.32	0.23	0.15	0.15	0.27	0.33	0.33
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	252	1236	536	151	1107	503	274	543	226	930	1168	512
v/s Ratio Prot	c0.05	c0.41		0.05	0.21		0.05	c0.18	0.13	c0.36	0.16	
v/s Ratio Perm	0.24		0.09	0.33		0.18	0.08					0.03
v/c Ratio	0.71	1.19	0.27	1.05	0.67	0.58	0.58	1.20	0.90	1.32	0.48	0.08
Uniform Delay, d1	24.9	39.5	28.7	35.1	35.4	34.2	38.8	51.2	50.4	43.8	32.0	27.7
Progression Factor	1.00	1.00	1.00	1.00	0.88	1.18	0.98	0.87	0.76	1.00	1.00	1.00
Incremental Delay, d2	7.6	94.9	1.3	82.6	2.9	4.4	1.5	105.3	29.7	153.6	0.1	0.0
Delay (s)	32.5	134.4	29.9	117.7	34.0	44.8	39.4	149.7	67.9	197.4	32.1	27.7
Level of Service	C	F	C	F	C	D	D	F	E	F	C	C
Approach Delay (s)		113.3			47.1			112.5			138.1	
Approach LOS		F			D			F			F	

Intersection Summary			
HCM Average Control Delay	104.8	HCM Level of Service	F
HCM Volume to Capacity ratio	1.23		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	113.9%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

6: Old US 56 & US 56

AM Peak Hour

Movement	NBL	NBR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	160	10	1870	980	10	1310
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	0.97	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	3433	1615	3654	1583	1805	3585
Flt Permitted	0.95	1.00	1.00	1.00	0.06	1.00
Satd. Flow (perm)	3433	1615	3654	1583	118	3585
Peak-hour factor, PHF	0.97	0.97	0.95	0.95	0.95	0.95
Adj. Flow (vph)	165	10	1968	1032	11	1379
RTOR Reduction (vph)	0	9	0	122	0	0
Lane Group Flow (vph)	165	1	1968	910	11	1379
Heavy Vehicles (%)	2%	0%	4%	2%	0%	6%
Turn Type		Perm		pm+ov	pm+pt	
Protected Phases	8		2	8	1	6
Permitted Phases		8	2	2	6	6
Actuated Green, G (s)	13.4	13.4	90.4	103.8	96.6	96.6
Effective Green, g (s)	13.4	13.4	90.4	103.8	96.6	96.6
Actuated g/C Ratio	0.11	0.11	0.75	0.86	0.80	0.80
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	383	180	2753	1435	112	2886
v/s Ratio Prot	0.05		c0.54	c0.07	0.00	c0.38
v/s Ratio Perm		0.00		0.50	0.08	
v/c Ratio	0.43	0.01	0.71	0.63	0.10	0.48
Uniform Delay, d1	49.7	47.4	7.9	2.4	9.4	3.7
Progression Factor	1.00	1.00	0.64	17.56	1.29	1.28
Incremental Delay, d2	0.8	0.0	0.1	0.1	0.2	0.1
Delay (s)	50.5	47.4	5.2	42.6	12.3	4.8
Level of Service	D	D	A	D	B	A
Approach Delay (s)	50.3		18.1			4.9
Approach LOS	D		B			A

Intersection Summary			
HCM Average Control Delay	15.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	72.3%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

7: US-56 & Cedar Niles

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	2050	160	680	2120	100	130	30	760	60	20	70
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2	5.2	5.2	5.2	5.2
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00	1.00	1.00	0.88	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1787	3689	1583	3433	3689	1583	1770	1942	2787	1752	2000	1553
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.74	1.00	1.00	0.74	1.00	1.00
Satd. Flow (perm)	1787	3689	1583	3433	3689	1583	1385	1942	2787	1358	2000	1553
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	2158	168	716	2232	105	137	32	800	63	21	74
RTOR Reduction (vph)	0	0	67	0	0	28	0	0	0	0	0	65
Lane Group Flow (vph)	74	2158	101	716	2232	77	137	32	800	63	21	9
Heavy Vehicles (%)	1%	3%	2%	2%	3%	2%	2%	3%	2%	3%	0%	4%
Turn Type	Prot		Perm	Prot		Perm	Perm		pt+ov	Perm		Perm
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases			2			6	8			4		4
Actuated Green, G (s)	5.6	68.8	68.8	23.0	86.2	86.2	12.6	12.6	40.8	12.6	12.6	12.6
Effective Green, g (s)	5.6	68.8	68.8	23.0	86.2	86.2	12.6	12.6	40.8	12.6	12.6	12.6
Actuated g/C Ratio	0.05	0.57	0.57	0.19	0.72	0.72	0.10	0.10	0.34	0.10	0.10	0.10
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2		5.2	5.2	5.2
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lane Grp Cap (vph)	83	2115	908	658	2650	1137	145	204	948	143	210	163
v/s Ratio Prot	0.04	c0.58		c0.21	0.60			0.02	c0.29		0.01	
v/s Ratio Perm			0.06			0.05	0.10			0.05		0.01
v/c Ratio	0.89	1.02	0.11	1.09	0.84	0.07	0.94	0.16	0.84	0.44	0.10	0.05
Uniform Delay, d1	56.9	25.6	11.7	48.5	12.1	5.0	53.4	48.9	36.7	50.4	48.6	48.3
Progression Factor	0.85	0.73	0.29	1.07	0.99	0.98	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	55.7	23.2	0.2	46.2	0.8	0.0	57.3	0.1	6.7	0.8	0.1	0.0
Delay (s)	103.9	42.0	3.6	98.1	12.8	4.9	110.7	49.0	43.3	51.2	48.6	48.4
Level of Service	F	D	A	F	B	A	F	D	D	D	D	D
Approach Delay (s)		41.2			32.5			53.0			49.5	
Approach LOS		D			C			D			D	

Intersection Summary			
HCM Average Control Delay	39.1	HCM Level of Service	D
HCM Volume to Capacity ratio	1.04		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.6
Intersection Capacity Utilization	102.8%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

8: US-56 & I-35 SB Ramps

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	2740	90	350	1470	0	0	0	0	210	0	1380
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		1.00		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3509		1719	3725					1736		2760
Flt Permitted		1.00		0.11	1.00					0.95		1.00
Satd. Flow (perm)		3509		202	3725					1736		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2884	95	368	1547	0	0	0	0	221	0	1453
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	8
Lane Group Flow (vph)	0	2977	0	368	1547	0	0	0	0	221	0	1445
Heavy Vehicles (%)	0%	2%	14%	5%	2%	0%	0%	0%	0%	4%	0%	3%
Turn Type				pm+pt						custom		custom
Protected Phases		2		1	6					4		5
Permitted Phases				6						4		4
Actuated Green, G (s)		77.0		51.8	51.8					12.0		53.2
Effective Green, g (s)		77.0		51.8	51.8					12.0		53.2
Actuated g/C Ratio		0.64		0.43	0.43					0.10		0.44
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2252		289	1608					174		1339
v/s Ratio Prot		c0.85		c0.17	0.42					0.13		c0.37
v/s Ratio Perm				0.38								0.15
v/c Ratio		1.32		1.27	0.96					1.27		1.08
Uniform Delay, d1		21.5		35.7	33.1					54.0		33.4
Progression Factor		0.72		0.90	0.87					1.00		1.00
Incremental Delay, d2		145.9		139.8	10.7					158.8		49.0
Delay (s)		161.4		171.8	39.5					212.8		82.4
Level of Service		F		F	D					F		F
Approach Delay (s)		161.4			65.0			0.0			99.6	
Approach LOS		F			E			A			F	

Intersection Summary			
HCM Average Control Delay	117.5	HCM Level of Service	F
HCM Volume to Capacity ratio	1.26		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	121.3%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner IMF Operations + Induced Development - (Improved + Mitigated) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

9: US-56 & I-35 NB Ramps

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1320	0	0	1650	510	170	0	690	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95	0.95			
Frt		1.00			1.00	0.85	1.00	0.85	0.85			
Flt Protected		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (prot)		3725			3539	1583	1687	1490	1490			
Flt Permitted		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (perm)		3725			3539	1583	1687	1490	1490			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1389	0	0	1737	537	179	0	726	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	106	0	0	0	0	0	0
Lane Group Flow (vph)	0	1389	0	0	1737	431	179	363	363	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	2%	7%	0%	3%	0%	0%	0%
Turn Type						Perm	Perm		Perm			
Protected Phases		2			6			8				
Permitted Phases						6	8		8			
Actuated Green, G (s)		75.2			75.2	75.2	34.8	34.8	34.8			
Effective Green, g (s)		75.2			75.2	75.2	34.8	34.8	34.8			
Actuated g/C Ratio		0.63			0.63	0.63	0.29	0.29	0.29			
Clearance Time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0	3.0			
Lane Grp Cap (vph)		2334			2218	992	489	432	432			
v/s Ratio Prot		0.37			c0.49			c0.24				
v/s Ratio Perm						0.27	0.11		0.24			
v/c Ratio		0.60			0.78	0.43	0.37	0.84	0.84			
Uniform Delay, d1		13.3			16.4	11.5	33.8	40.0	40.0			
Progression Factor		0.49			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2		0.1			1.9	0.3	0.5	13.7	13.7			
Delay (s)		6.7			18.3	11.8	34.3	53.7	53.7			
Level of Service		A			B	B	C	D	D			
Approach Delay (s)		6.7			16.8			49.9			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	20.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	104.3%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

10: Santa Fe & Moonlight Road

AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	120	330	710	240	460	410
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.96		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3380		1770	3505
Flt Permitted	0.95	1.00	1.00		0.21	1.00
Satd. Flow (perm)	1770	1583	3380		393	3505
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	126	347	747	253	484	432
RTOR Reduction (vph)	0	307	21	0	0	0
Lane Group Flow (vph)	126	40	979	0	484	432
Heavy Vehicles (%)	2%	2%	3%	2%	2%	3%
Turn Type		Perm			pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8			6	
Actuated Green, G (s)	13.8	13.8	63.9		96.2	96.2
Effective Green, g (s)	13.8	13.8	63.9		96.2	96.2
Actuated g/C Ratio	0.12	0.12	0.53		0.80	0.80
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	204	182	1800		628	2810
v/s Ratio Prot	c0.07		0.29		c0.18	0.12
v/s Ratio Perm		0.03			c0.44	
v/c Ratio	0.62	0.22	0.54		0.77	0.15
Uniform Delay, d1	50.6	48.2	18.5		18.5	2.7
Progression Factor	1.00	1.00	1.00		0.63	0.94
Incremental Delay, d2	5.5	0.6	1.2		5.0	0.1
Delay (s)	56.1	48.8	19.6		16.7	2.6
Level of Service	E	D	B		B	A
Approach Delay (s)	50.7		19.6			10.1
Approach LOS	D		B			B

Intersection Summary			
HCM Average Control Delay	22.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	71.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

11: Waverly Road & US 56

AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	20	250	140	550	280	40	70	140	20	200	70	300
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95		1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.98		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1805	3539	1482	3400	3469		1736	3312	1615	1736	2935	1568
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1805	3539	1482	3400	3469		1736	3312	1615	1736	2935	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	263	147	579	295	42	74	147	21	211	74	316
RTOR Reduction (vph)	0	0	127	0	13	0	0	0	18	0	0	223
Lane Group Flow (vph)	21	263	20	579	324	0	74	147	3	211	74	93
Heavy Vehicles (%)	0%	2%	9%	3%	1%	10%	4%	9%	0%	4%	23%	3%
Turn Type	Prot		Perm	Prot			Prot		Perm	Prot		Perm
Protected Phases	3	8		7	4		5	2		1	6	
Permitted Phases			8					2	2			6
Actuated Green, G (s)	3.1	12.1	12.1	23.5	32.5		7.9	12.2	12.2	22.2	26.5	26.5
Effective Green, g (s)	3.1	12.1	12.1	23.5	32.5		7.9	12.2	12.2	22.2	26.5	26.5
Actuated g/C Ratio	0.03	0.13	0.13	0.26	0.36		0.09	0.14	0.14	0.25	0.29	0.29
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	62	476	199	888	1253		152	449	219	428	864	462
v/s Ratio Prot	0.01	c0.07		c0.17	0.09		0.04	c0.04		c0.12	0.03	
v/s Ratio Perm			0.01						0.00			0.06
v/c Ratio	0.34	0.55	0.10	0.65	0.26		0.49	0.33	0.01	0.49	0.09	0.20
Uniform Delay, d1	42.4	36.4	34.2	29.6	20.3		39.1	35.2	33.7	29.1	23.0	23.8
Progression Factor	1.00	1.00	1.00	0.96	0.95		1.01	0.81	0.52	1.15	0.69	0.62
Incremental Delay, d2	3.2	1.4	0.2	1.5	0.1		2.2	1.8	0.1	0.8	0.2	0.8
Delay (s)	45.7	37.8	34.4	29.9	19.4		41.8	30.1	17.5	34.3	16.0	15.7
Level of Service	D	D	C	C	B		D	C	B	C	B	B
Approach Delay (s)		37.0			26.0			32.6			22.3	
Approach LOS		D			C			C			C	

Intersection Summary			
HCM Average Control Delay	27.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	54.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

12: 183rd Street & Four Corners Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	20	5	5	40	5	10	20	5	5	50	5
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	21	5	5	42	5	11	21	5	5	53	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	32	53	37	63
Volume Left (vph)	5	5	11	5
Volume Right (vph)	5	5	5	5
Hadj (s)	-0.07	0.00	0.02	0.02
Departure Headway (s)	4.1	4.2	4.2	4.1
Degree Utilization, x	0.04	0.06	0.04	0.07
Capacity (veh/h)	849	842	834	847
Control Delay (s)	7.3	7.4	7.4	7.5
Approach Delay (s)	7.3	7.4	7.4	7.5
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.4		
HCM Level of Service	A		
Intersection Capacity Utilization	14.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)
13: 183rd Street & US 56 — AM Peak Hour

Intersection Sign configuration not allowed in HCM analysis.

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)
14: 183rd Street & Waverly Road — AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	20	230	240	20	180	210
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	242	253	21	189	221
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	863	263			274	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	863	263			274	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	92	69			85	
cM capacity (veh/h)	280	780			1301	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	263	274	411
Volume Left	21	0	189
Volume Right	242	21	0
cSH	683	1700	1301
Volume to Capacity	0.39	0.16	0.15
Queue Length 95th (ft)	45	0	13
Control Delay (s)	13.5	0.0	4.5
Lane LOS	B		A
Approach Delay (s)	13.5	0.0	4.5
Approach LOS	B		

Intersection Summary			
Average Delay	5.7		
Intersection Capacity Utilization	60.2%	ICU Level of Service	B
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)
15: 183rd Street & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	120	80	200	240	120	120	200	1050	210	90	920	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.89		1.00	0.92		1.00	0.98		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1658		1770	1723		1787	3423		1770	3452	
Flt Permitted	0.48	1.00		0.23	1.00		0.20	1.00		0.11	1.00	
Satd. Flow (perm)	896	1658		421	1723		371	3423		205	3452	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	126	84	211	253	126	126	211	1105	221	95	968	116
RTOR Reduction (vph)	0	103	0	0	0	0	0	17	0	0	10	0
Lane Group Flow (vph)	126	192	0	253	252	0	211	1309	0	95	1074	0
Heavy Vehicles (%)	2%	3%	2%	2%	2%	2%	1%	3%	2%	2%	3%	2%
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	19.7	13.7		27.7	17.7		42.4	42.4		40.3	40.3	
Effective Green, g (s)	19.7	13.7		27.7	17.7		42.4	42.4		40.3	40.3	
Actuated g/C Ratio	0.22	0.15		0.31	0.20		0.47	0.47		0.45	0.45	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	254	252		279	339		269	1613		160	1546	
v/s Ratio Prot	0.03	0.12		c0.10	0.15		0.05	c0.38		0.03	c0.31	
v/s Ratio Perm	0.08			c0.18			0.32			0.24		
v/c Ratio	0.50	0.76		0.91	0.74		0.78	0.81		0.59	0.69	
Uniform Delay, d1	29.6	36.6		26.8	34.0		26.9	20.4		20.0	19.9	
Progression Factor	1.14	1.11		1.00	1.00		0.67	0.59		0.64	0.79	
Incremental Delay, d2	1.5	12.6		30.5	8.5		10.0	3.2		4.1	1.8	
Delay (s)	35.3	53.1		57.3	42.5		28.1	15.3		16.9	17.7	
Level of Service	D	D		E	D		C	B		B	B	
Approach Delay (s)		47.8			49.9			17.1			17.6	
Approach LOS		D			D			B			B	

Intersection Summary			
HCM Average Control Delay	25.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	87.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)
16: Four Corners Road & US 56 — AM Peak Hour

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	0	50	30	190	80	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	0	53	32	200	84	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	347	84	84			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	347	84	84			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	95	98			
cM capacity (veh/h)	640	975	1506			

Direction, Lane #	SB 1	NE 1	SW 1
Volume Total	53	232	84
Volume Left	0	32	0
Volume Right	53	0	0
cSH	975	1506	1700
Volume to Capacity	0.05	0.02	0.05
Queue Length 95th (ft)	4	2	0
Control Delay (s)	8.9	1.2	0.0
Lane LOS	A	A	
Approach Delay (s)	8.9	1.2	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	2.0		
Intersection Capacity Utilization	28.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

17: 191st Street & US 56 — AM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	20	5	5	200	70	60
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	5	5	211	74	63
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	326	105	137			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	326	105	137			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	99	100			
cM capacity (veh/h)	670	955	1460			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	26	216	137
Volume Left	21	5	0
Volume Right	5	0	63
cSH	712	1460	1700
Volume to Capacity	0.04	0.00	0.08
Queue Length 95th (ft)	3	0	0
Control Delay (s)	10.2	0.2	0.0
Lane LOS	B	A	
Approach Delay (s)	10.2	0.2	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	24.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

18: 191st Street & Four Corners Road — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	10	10	110	30	30	120
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.95	0.92	0.92	0.95
Hourly flow rate (vph)	11	11	116	33	33	126
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			22		280	16
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			22		280	16
tC, single (s)			5.0		6.6	7.1
tC, 2 stage (s)						
tF (s)			3.0		3.7	4.1
p0 queue free %			90		95	85
cM capacity (veh/h)			1157		611	860

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	22	148	159
Volume Left	0	116	33
Volume Right	11	0	126
cSH	1700	1157	794
Volume to Capacity	0.01	0.10	0.20
Queue Length 95th (ft)	0	8	19
Control Delay (s)	0.0	6.8	10.7
Lane LOS		A	B
Approach Delay (s)	0.0	6.8	10.7
Approach LOS			B

Intersection Summary			
Average Delay	8.2		
Intersection Capacity Utilization	30.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

19: 191st Street & Waverly Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	90	70	70	10	160	50	40	110	30	50	50	130
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	95	74	74	11	168	53	42	116	32	53	53	137

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	242	232	189	242
Volume Left (vph)	95	11	42	53
Volume Right (vph)	74	53	32	137
Hadj (s)	0.46	-0.11	0.05	-0.26
Departure Headway (s)	6.0	5.5	5.8	5.4
Degree Utilization, x	0.40	0.35	0.30	0.36
Capacity (veh/h)	556	601	560	610
Control Delay (s)	13.0	11.4	11.3	11.4
Approach Delay (s)	13.0	11.4	11.3	11.4
Approach LOS	B	B	B	B

Intersection Summary			
Delay	11.8		
HCM Level of Service	B		
Intersection Capacity Utilization	52.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

20: W 188th Street & Gardner Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	30	260	210	30	240	330	1010	260	260	1240	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	5.0	5.0	5.0	2.5	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.87		1.00	0.97		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1787	1845	1583	1770	1613		1752	3526		1770	3689	1553
Flt Permitted	0.31	1.00	1.00	0.74	1.00		0.10	1.00		0.11	1.00	1.00
Satd. Flow (perm)	583	1845	1583	1370	1613		187	3526		206	3689	1553
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	84	33	274	228	33	261	347	1063	283	283	1305	116
RTOR Reduction (vph)	0	0	235	0	224	0	0	26	0	0	0	65
Lane Group Flow (vph)	84	33	39	228	70	0	347	1320	0	283	1305	51
Heavy Vehicles (%)	1%	3%	2%	2%	3%	2%	3%	5%	2%	2%	3%	4%
Turn Type	pm+pt		Perm	pm+pt			pm+pt			pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	16.9	12.9	12.9	19.0	12.7		56.6	39.4		50.0	36.1	36.1
Effective Green, g (s)	16.9	12.9	12.9	19.0	12.7		56.6	39.4		50.0	36.1	36.1
Actuated g/C Ratio	0.19	0.14	0.14	0.21	0.14		0.63	0.44		0.56	0.40	0.40
Clearance Time (s)	5.0	5.0	5.0	2.5	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	163	264	227	317	228		417	1544		356	1480	623
v/s Ratio Prot	0.02	0.02		c0.05	0.04		c0.16	c0.37		0.12	0.35	
v/s Ratio Perm	0.07		0.02	c0.10			0.36			0.32		0.03
v/c Ratio	0.52	0.12	0.17	0.72	0.31		0.83	0.85		0.79	0.88	0.08
Uniform Delay, d1	31.6	33.6	33.9	32.4	34.7		24.3	22.7		21.4	25.0	16.7
Progression Factor	1.00	1.00	1.00	1.00	1.00		0.85	1.27		1.25	0.61	0.54
Incremental Delay, d2	2.7	0.2	0.4	7.6	0.8		11.3	5.3		9.4	5.3	0.0
Delay (s)	34.3	33.8	34.2	40.0	35.5		32.1	34.2		36.1	20.5	9.1
Level of Service	C	C	C	D	D		C	C		D	C	A
Approach Delay (s)		34.2			37.4			33.7			22.4	
Approach LOS		C			D			C			C	

Intersection Summary			
HCM Average Control Delay	29.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	88.3%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

21: I-35 SB Ramps & Gardner Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	210	0	770	10	830	0	0	1540	170
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)				5.0	5.0	2.5	2.5	5.0			5.0	
Lane Util. Factor				1.00	0.95	0.95	1.00	0.95			0.95	
Frt				1.00	0.85	0.85	1.00	1.00			0.99	
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1703	1447	1447	1805	3689			3663	
Flt Permitted				0.95	1.00	1.00	0.10	1.00			1.00	
Satd. Flow (perm)				1703	1447	1447	191	3689			3663	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	221	0	811	11	874	0	0	1621	179
RTOR Reduction (vph)	0	0	0	0	287	40	0	0	0	0	7	0
Lane Group Flow (vph)	0	0	0	221	119	365	11	874	0	0	1793	0
Heavy Vehicles (%)	0%	0%	0%	6%	0%	6%	0%	3%	0%	0%	2%	4%
Turn Type				custom		custom	pm+pt					
Protected Phases				8	8	1	5	2			6	
Permitted Phases				8		8	2					
Actuated Green, G (s)				16.5	16.5	37.7	40.9	39.8			59.9	
Effective Green, g (s)				16.5	16.5	37.7	40.9	39.8			59.9	
Actuated g/C Ratio				0.18	0.18	0.42	0.45	0.44			0.67	
Clearance Time (s)				5.0	5.0	2.5	2.5	5.0			5.0	
Vehicle Extension (s)				3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)				312	265	646	107	1631			2438	
v/s Ratio Prot				c0.13	0.08	c0.13	0.00	0.24			c0.49	
v/s Ratio Perm						0.12	0.05					
v/c Ratio				0.71	0.45	0.56	0.10	0.54			0.74	
Uniform Delay, d1				34.5	32.7	19.9	18.0	18.3			9.9	
Progression Factor				1.00	1.00	1.00	1.07	0.37			0.52	
Incremental Delay, d2				7.2	1.2	1.1	0.1	0.3			1.2	
Delay (s)				41.7	33.9	21.0	19.3	7.2			6.3	
Level of Service				D	C	C	B	A			A	
Approach Delay (s)		0.0			30.5			7.3			6.3	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM Average Control Delay	13.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	93.3%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

22: I-35 NB Ramps & Gardner Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	360	0	40	0	0	0	0	480	450	1070	690	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0						5.0	5.0	5.0	5.0	
Lane Util. Factor		1.00						1.00	1.00	0.97	0.95	
Frt		0.99						1.00	0.85	1.00	1.00	
Flt Protected		0.96						1.00	1.00	0.95	1.00	
Satd. Flow (prot)		1753						1942	1583	3433	3725	
Flt Permitted		0.96						1.00	1.00	0.95	1.00	
Satd. Flow (perm)		1753						1942	1583	3433	3725	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	379	0	42	0	0	0	0	505	474	1126	726	0
RTOR Reduction (vph)	0	5	0	0	0	0	0	0	334	0	0	0
Lane Group Flow (vph)	0	416	0	0	0	0	0	505	140	1126	726	0
Heavy Vehicles (%)	2%	0%	5%	0%	0%	0%	0%	3%	2%	2%	2%	0%
Turn Type	Split								Perm	Prot		
Protected Phases	4	4						2		1	6	
Permitted Phases									2			
Actuated Green, G (s)		21.0						24.0	24.0	30.0	59.0	
Effective Green, g (s)		21.0						24.0	24.0	30.0	59.0	
Actuated g/C Ratio		0.23						0.27	0.27	0.33	0.66	
Clearance Time (s)		5.0						5.0	5.0	5.0	5.0	
Vehicle Extension (s)		3.0						3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)		409						518	422	1144	2442	
v/s Ratio Prot		c0.24						c0.26		c0.33	0.19	
v/s Ratio Perm									0.09			
v/c Ratio		1.02						0.97	0.33	0.98	0.30	
Uniform Delay, d1		34.5						32.7	26.6	29.8	6.6	
Progression Factor		1.00						0.84	0.83	0.74	0.45	
Incremental Delay, d2		49.2						30.4	1.8	18.6	0.2	
Delay (s)		83.7						58.0	23.8	40.7	3.2	
Level of Service		F						E	C	D	A	
Approach Delay (s)		83.7			0.0			41.4			26.0	
Approach LOS		F			A			D			C	

Intersection Summary			
HCM Average Control Delay	38.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	93.3%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

23: E 191st Street & Gardner Rd

AM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	20	80	850	20	100	640
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		5.0			5.0
Lane Util. Factor	1.00		1.00			1.00
Frt	0.89		1.00			1.00
Flt Protected	0.99		1.00			0.99
Satd. Flow (prot)	1639		1840			1843
Flt Permitted	0.99		1.00			0.77
Satd. Flow (perm)	1639		1840			1425
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	84	895	21	105	674
RTOR Reduction (vph)	78	0	1	0	0	0
Lane Group Flow (vph)	27	0	915	0	0	779
Heavy Vehicles (%)	0%	3%	3%	0%	5%	2%
Turn Type					Perm	
Protected Phases	8		2			6
Permitted Phases					6	
Actuated Green, G (s)	6.4		73.6			73.6
Effective Green, g (s)	6.4		73.6			73.6
Actuated g/C Ratio	0.07		0.82			0.82
Clearance Time (s)	5.0		5.0			5.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	117		1505			1165
v/s Ratio Prot	c0.02		0.50			
v/s Ratio Perm						c0.55
v/c Ratio	0.23		0.61			0.67
Uniform Delay, d1	39.5		3.0			3.3
Progression Factor	1.00		0.82			1.25
Incremental Delay, d2	1.0		0.6			2.9
Delay (s)	40.5		3.1			7.1
Level of Service	D		A			A
Approach Delay (s)	40.5		3.1			7.1
Approach LOS	D		A			A

Intersection Summary			
HCM Average Control Delay	7.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	103.7%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

24: Sunflower Road & US 56

AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	5	40	5	270	70	10	5	190	370	10	60	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.99			1.00			0.91			1.00	
Flt Protected		1.00			0.96			1.00			0.99	
Satd. Flow (prot)		1866			1778			1665			1635	
Flt Permitted		0.97			0.74			1.00			0.92	
Satd. Flow (perm)		1811			1368			1664			1522	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	5	42	5	284	74	11	5	200	389	11	63	0
RTOR Reduction (vph)	0	3	0	0	1	0	0	67	0	0	0	0
Lane Group Flow (vph)	0	49	0	0	368	0	0	527	0	0	74	0
Heavy Vehicles (%)	0%	0%	0%	3%	1%	0%	0%	6%	3%	0%	18%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		28.2			28.2			51.8			51.8	
Effective Green, g (s)		28.2			28.2			51.8			51.8	
Actuated g/C Ratio		0.31			0.31			0.58			0.58	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		567			429			958			876	
v/s Ratio Prot												
v/s Ratio Perm		0.03			c0.27			c0.32			0.05	
v/c Ratio		0.09			0.86			0.55			0.08	
Uniform Delay, d1		21.8			29.0			11.9			8.5	
Progression Factor		1.00			1.00			1.34			1.26	
Incremental Delay, d2		0.1			15.4			2.0			0.2	
Delay (s)		21.9			44.4			17.9			10.9	
Level of Service		C			D			B			B	
Approach Delay (s)		21.9			44.4			17.9			10.9	
Approach LOS		C			D			B			B	

Intersection Summary			
HCM Average Control Delay	26.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	67.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner IMF Operations + Induced Development - (Improved + Mitigated) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

25: US 56 & 4th Street

AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	480	130	80	260	110	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0			5.0	5.0	
Lane Util. Factor	1.00			1.00	1.00	
Frt	0.97			1.00	0.94	
Flt Protected	1.00			0.99	0.97	
Satd. Flow (prot)	1778			1780	1676	
Flt Permitted	1.00			0.77	0.97	
Satd. Flow (perm)	1778			1388	1676	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	505	137	84	274	116	95
RTOR Reduction (vph)	8	0	0	0	36	0
Lane Group Flow (vph)	634	0	0	358	175	0
Heavy Vehicles (%)	4%	3%	4%	6%	5%	2%
Turn Type			Perm			
Protected Phases	4			8	2	
Permitted Phases			8			
Actuated Green, G (s)	65.5			65.5	14.5	
Effective Green, g (s)	65.5			65.5	14.5	
Actuated g/C Ratio	0.73			0.73	0.16	
Clearance Time (s)	5.0			5.0	5.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	1294			1010	270	
v/s Ratio Prot	c0.36				c0.10	
v/s Ratio Perm				0.26		
v/c Ratio	0.49			0.35	0.65	
Uniform Delay, d1	5.2			4.5	35.4	
Progression Factor	1.00			2.49	1.00	
Incremental Delay, d2	1.3			0.8	5.3	
Delay (s)	6.5			12.0	40.6	
Level of Service	A			B	D	
Approach Delay (s)	6.5			12.0	40.6	
Approach LOS	A			B	D	

Intersection Summary			
HCM Average Control Delay	14.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	75.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

26: 199th Street & Four Corners Road

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	10	420	360	140	110	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0		5.0	
Lane Util. Factor		1.00	1.00		1.00	
Frt		1.00	0.96		0.99	
Flt Protected		1.00	1.00		0.95	
Satd. Flow (prot)		1853	1480		918	
Flt Permitted		0.99	1.00		0.95	
Satd. Flow (perm)		1831	1480		918	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	11	442	379	147	116	5
RTOR Reduction (vph)	0	0	19	0	2	0
Lane Group Flow (vph)	0	453	507	0	119	0
Heavy Vehicles (%)	20%	2%	2%	79%	98%	60%
Turn Type	Perm					
Protected Phases		4	8		6	
Permitted Phases	4					
Actuated Green, G (s)		30.9	30.9		9.9	
Effective Green, g (s)		30.9	30.9		9.9	
Actuated g/C Ratio		0.61	0.61		0.19	
Clearance Time (s)		5.0	5.0		5.0	
Vehicle Extension (s)		3.0	3.0		3.0	
Lane Grp Cap (vph)		1114	900		179	
v/s Ratio Prot			c0.34		c0.13	
v/s Ratio Perm		0.25				
v/c Ratio		0.41	0.56		0.66	
Uniform Delay, d1		5.2	5.9		18.9	
Progression Factor		1.00	1.00		1.00	
Incremental Delay, d2		0.2	0.8		8.9	
Delay (s)		5.4	6.7		27.8	
Level of Service		A	A		C	
Approach Delay (s)		5.4	6.7		27.8	
Approach LOS		A	A		C	

Intersection Summary			
HCM Average Control Delay	8.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	50.8	Sum of lost time (s)	10.0
Intersection Capacity Utilization	44.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

27: 199th Street & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	160	10	30	170	450	10	260	20	290	90	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00		1.00		1.00	1.00	1.00
Frt	1.00	0.99		1.00	1.00	0.85		0.99		1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		1.00		0.95	1.00	1.00
Satd. Flow (prot)	1752	1782		1752	1845	1583		1830		1770	1863	1583
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.99		0.45	1.00	1.00
Satd. Flow (perm)	1752	1782		1752	1845	1583		1818		837	1863	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	42	168	11	32	179	474	11	274	21	305	95	53
RTOR Reduction (vph)	0	3	0	0	0	393	0	2	0	0	0	20
Lane Group Flow (vph)	42	176	0	32	179	81	0	304	0	305	95	33
Heavy Vehicles (%)	3%	6%	0%	3%	3%	2%	0%	3%	0%	2%	2%	2%
Turn Type	Prot			Prot		Perm	Perm			pm+pt		Perm
Protected Phases	5	2		1	6			8		7	4	
Permitted Phases						6	8			4		4
Actuated Green, G (s)	4.4	14.1		5.6	15.3	15.3		37.7		55.3	55.3	55.3
Effective Green, g (s)	4.4	14.1		5.6	15.3	15.3		37.7		55.3	55.3	55.3
Actuated g/C Ratio	0.05	0.16		0.06	0.17	0.17		0.42		0.61	0.61	0.61
Clearance Time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	86	279		109	314	269		762		645	1145	973
v/s Ratio Prot	0.02	c0.10		0.02	c0.10					c0.07	0.05	
v/s Ratio Perm						0.05		0.17		c0.22		0.02
v/c Ratio	0.49	0.63		0.29	0.57	0.30		0.40		0.47	0.08	0.03
Uniform Delay, d1	41.7	35.5		40.3	34.3	32.7		18.2		9.4	7.0	6.8
Progression Factor	1.03	1.07		1.00	1.00	1.00		1.00		1.13	1.03	1.60
Incremental Delay, d2	4.3	4.4		1.5	2.5	0.6		1.6		0.4	0.1	0.0
Delay (s)	47.3	42.4		41.8	36.8	33.3		19.8		11.0	7.4	11.0
Level of Service	D	D		D	D	C		B		B	A	B
Approach Delay (s)		43.3			34.6			19.8			10.2	
Approach LOS		D			C			B			B	

Intersection Summary			
HCM Average Control Delay	26.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	60.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

30: US-56 & I-35 NB Loop

AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	1320	1630	0	1820	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	1389	1716	0	1916	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked					0.60	
vC, conflicting volume			3105		2347	695
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			3105		1909	695
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			106		37	389

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	695	695	1716	958	958
Volume Left	0	0	0	0	0
Volume Right	0	0	1716	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.41	0.41	1.01	0.56	0.56
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	104.3%	ICU Level of Service	G
Analysis Period (min)	15		

2030 Gardner IMF Operations + Induced Development - (Improved + Mitigated) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

37: 199th Street & West Waverley — AM Peak Hour

Movement	EBL	EBT	WBU	WBT	WBR	SWL	SWR
Lane Configurations							
Volume (vph)	10	770	0	760	170	120	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0		5.0	
Lane Util. Factor	1.00	1.00		1.00		1.00	
Frt	1.00	1.00		0.97		0.99	
Flt Protected	0.95	1.00		1.00		0.96	
Satd. Flow (prot)	1805	1638		1619		1171	
Flt Permitted	0.18	1.00		1.00		0.96	
Satd. Flow (perm)	344	1638		1619		1171	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	837	0	826	185	130	11
RTOR Reduction (vph)	0	0	0	8	0	3	0
Lane Group Flow (vph)	11	837	0	1003	0	138	0
Heavy Vehicles (%)	0%	16%	2%	16%	6%	58%	0%
Turn Type	Perm		Perm				
Protected Phases		4		8		6	
Permitted Phases	4		8				
Actuated Green, G (s)	65.9	65.9		65.9		14.1	
Effective Green, g (s)	65.9	65.9		65.9		14.1	
Actuated g/C Ratio	0.73	0.73		0.73		0.16	
Clearance Time (s)	5.0	5.0		5.0		5.0	
Vehicle Extension (s)	3.0	3.0		3.0		3.0	
Lane Grp Cap (vph)	252	1199		1185		183	
v/s Ratio Prot		0.51		c0.62		c0.12	
v/s Ratio Perm	0.03						
v/c Ratio	0.04	0.70		0.85		0.75	
Uniform Delay, d1	3.3	6.6		8.5		36.3	
Progression Factor	1.00	1.00		0.72		1.00	
Incremental Delay, d2	0.3	3.4		5.4		15.9	
Delay (s)	3.7	10.0		11.6		52.2	
Level of Service	A	A		B		D	
Approach Delay (s)		9.9		11.6		52.2	
Approach LOS		A		B		D	

Intersection Summary			
HCM Average Control Delay	13.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	65.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

38: 199th Street & IH-35 SB Ramp — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	820	70	50	350	0	0	0	0	10	0	580
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		1.00		1.00	1.00					1.00		1.00
Frt		0.99		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		1552		1770	1827					1805		1335
Flt Permitted		1.00		0.21	1.00					0.95		1.00
Satd. Flow (perm)		1552		388	1827					1805		1335
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	891	76	54	380	0	0	0	0	11	0	630
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	575
Lane Group Flow (vph)	0	965	0	54	380	0	0	0	0	11	0	55
Heavy Vehicles (%)	0%	22%	11%	2%	4%	0%	0%	0%	0%	0%	0%	21%
Turn Type				pm+pt						Prot		custom
Protected Phases		4		3	8					6		
Permitted Phases				8								6
Actuated Green, G (s)		65.6		75.0	75.0					5.0		5.0
Effective Green, g (s)		65.6		75.0	75.0					5.0		5.0
Actuated g/C Ratio		0.73		0.83	0.83					0.06		0.06
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		1131		391	1523					100		74
v/s Ratio Prot		c0.62		0.01	c0.21					0.01		
v/s Ratio Perm				0.11								c0.04
v/c Ratio		0.85		0.14	0.25					0.11		0.74
Uniform Delay, d1		8.7		9.0	1.6					40.4		41.9
Progression Factor		0.75		0.06	0.05					1.00		1.00
Incremental Delay, d2		6.0		0.1	0.1					0.5		32.4
Delay (s)		12.5		0.6	0.1					40.9		74.3
Level of Service		B		A	A					D		E
Approach Delay (s)		12.5			0.2			0.0			73.7	
Approach LOS		B			A			A			E	

Intersection Summary			
HCM Average Control Delay	29.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	77.0%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

39: 199th Street & IH-35 NB Ramp — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	750	80	0	0	160	20	240	0	90	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0		5.0			
Lane Util. Factor	1.00	1.00			1.00		1.00		1.00			
Frt	1.00	1.00			0.98		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1456	1759			1823		1736		1583			
Flt Permitted	0.49	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	749	1759			1823		1736		1583			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	815	87	0	0	174	22	261	0	98	0	0	0
RTOR Reduction (vph)	0	0	0	0	5	0	0	0	81	0	0	0
Lane Group Flow (vph)	815	87	0	0	191	0	261	0	17	0	0	0
Heavy Vehicles (%)	24%	8%	0%	0%	3%	0%	4%	0%	2%	0%	0%	0%
Turn Type	pm+pt						custom		custom			
Protected Phases	7	4			8							
Permitted Phases	4						2		2			
Actuated Green, G (s)	64.5	64.5			13.8		15.5		15.5			
Effective Green, g (s)	64.5	64.5			13.8		15.5		15.5			
Actuated g/C Ratio	0.72	0.72			0.15		0.17		0.17			
Clearance Time (s)	5.0	5.0			5.0		5.0		5.0			
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Lane Grp Cap (vph)	896	1261			280		299		273			
v/s Ratio Prot	c0.46	0.05			0.10							
v/s Ratio Perm	c0.19						c0.15		0.01			
v/c Ratio	0.91	0.07			0.68		0.87		0.06			
Uniform Delay, d1	12.6	3.8			36.0		36.3		31.2			
Progression Factor	0.38	0.05			0.98		1.00		1.00			
Incremental Delay, d2	7.5	0.1			6.5		23.3		0.1			
Delay (s)	12.3	0.2			41.9		59.6		31.3			
Level of Service	B	A			D		E		C			
Approach Delay (s)		11.1			41.9			51.8			0.0	
Approach LOS		B			D			D			A	

Intersection Summary			
HCM Average Control Delay	25.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	77.0%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

40: 199th Street & East Waverley — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	160	10	5	170	10	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	174	11	5	185	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	820					
pX, platoon unblocked						
vC, conflicting volume			185		375	179
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			185		375	179
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	99
cM capacity (veh/h)			1402		628	869

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	185	190	16
Volume Left	0	5	11
Volume Right	11	0	5
cSH	1700	1402	692
Volume to Capacity	0.11	0.00	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.2	10.3
Lane LOS		A	B
Approach Delay (s)	0.0	0.2	10.3
Approach LOS			B

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	23.0%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner IMF Operations + Induced Development - (Improved + Mitigated) - AM Peak Hour - Synchro Intersection LOS

80: 191st Street & Driveway A

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	110	10	30	10	70	110
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	120	11	33	11	76	120
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	43				288	38
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	43				288	38
tC, single (s)	5.1				7.4	7.2
tC, 2 stage (s)						
tF (s)	3.1				4.4	4.2
p0 queue free %	89				84	85
cM capacity (veh/h)	1112				479	812

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	130	43	76	120
Volume Left	120	0	76	0
Volume Right	0	11	0	120
cSH	1112	1700	479	812
Volume to Capacity	0.11	0.03	0.16	0.15
Queue Length 95th (ft)	9	0	14	13
Control Delay (s)	8.0	0.0	13.9	10.2
Lane LOS	A		B	B
Approach Delay (s)	8.0	0.0	11.6	
Approach LOS			B	

Intersection Summary			
Average Delay	9.0		
Intersection Capacity Utilization	23.8%	ICU Level of Service	A
Analysis Period (min)	15		

81: 191st Street & Driveway B

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	180	140	170	30	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	196	152	185	33	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	337				462	245
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	337				462	245
tC, single (s)	4.5				6.8	6.8
tC, 2 stage (s)						
tF (s)	2.6				3.8	3.8
p0 queue free %	99				93	99
cM capacity (veh/h)	1038				494	671

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	207	337	33	5
Volume Left	11	0	33	0
Volume Right	0	185	0	5
cSH	1038	1700	494	671
Volume to Capacity	0.01	0.20	0.07	0.01
Queue Length 95th (ft)	1	0	5	1
Control Delay (s)	0.5	0.0	12.8	10.4
Lane LOS	A		B	B
Approach Delay (s)	0.5	0.0	12.5	
Approach LOS			B	

Intersection Summary			
Average Delay	1.0		
Intersection Capacity Utilization	27.8%	ICU Level of Service	A
Analysis Period (min)	15		

82: Driveway C & Waverly Road

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	60	50	50	190	180	50
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	65	54	54	207	196	54
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	538	223	250			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	538	223	250			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	87	93	96			
cM capacity (veh/h)	487	822	1327			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	65	54	261	250
Volume Left	65	0	54	0
Volume Right	0	54	0	54
cSH	487	822	1327	1700
Volume to Capacity	0.13	0.07	0.04	0.15
Queue Length 95th (ft)	12	5	3	0
Control Delay (s)	13.5	9.7	1.9	0.0
Lane LOS	B	A	A	
Approach Delay (s)	11.8		1.9	0.0
Approach LOS	B			

Intersection Summary			
Average Delay	3.0		
Intersection Capacity Utilization	38.6%	ICU Level of Service	A
Analysis Period (min)	15		

83: Driveway D & Waverly Road

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	20	10	90	370	380	110
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	22	11	98	402	413	120
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	870	266	533			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	870	266	533			
tC, single (s)	7.6	7.1	4.1			
tC, 2 stage (s)						
tF (s)	3.9	3.4	2.2			
p0 queue free %	89	98	91			
cM capacity (veh/h)	206	708	1038			

Direction, Lane #	EB 1	EB 2	NB 1	NB 2	SB 1	SB 2
Volume Total	22	11	232	268	275	257
Volume Left	22	0	98	0	0	0
Volume Right	0	11	0	0	0	120
cSH	206	708	1038	1700	1700	1700
Volume to Capacity	0.11	0.02	0.09	0.16	0.16	0.15
Queue Length 95th (ft)	9	1	8	0	0	0
Control Delay (s)	24.5	10.2	4.2	0.0	0.0	0.0
Lane LOS	C	B	A			
Approach Delay (s)	19.7		2.0		0.0	
Approach LOS	C					

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	40.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)
84: 191st Street & Driveway E — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	80	30	20	20	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	87	33	22	22	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	54				152	43
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	54				152	43
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				97	99
cM capacity (veh/h)	1564				838	1033

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	98	54	27
Volume Left	11	0	22
Volume Right	0	22	5
cSH	1564	1700	871
Volume to Capacity	0.01	0.03	0.03
Queue Length 95th (ft)	1	0	2
Control Delay (s)	0.9	0.0	9.3
Lane LOS	A		A
Approach Delay (s)	0.9	0.0	9.3
Approach LOS			A

Intersection Summary			
Average Delay	1.9		
Intersection Capacity Utilization	21.4%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner IMF Operations + Induced Development - (Improved + Mitigated) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

1: 175th Street & Waverly Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Volume (vph)	50	10	390	10	20	30	690	280	10	10	160	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.91		1.00	0.99		1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1659		1805	1819		1770	3523		1805	3426	
Flt Permitted	0.72	1.00		0.38	1.00		0.62	1.00		0.57	1.00	
Satd. Flow (perm)	1346	1659		724	1819		1155	3523		1074	3426	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	53	11	411	11	21	32	726	295	11	11	168	42
RTOR Reduction (vph)	0	363	0	0	28	0	0	2	0	0	16	0
Lane Group Flow (vph)	53	59	0	11	25	0	726	304	0	11	194	0
Heavy Vehicles (%)	2%	0%	3%	0%	0%	0%	2%	2%	0%	0%	2%	3%
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	10.5	10.5		10.5	10.5		69.5	61.4		46.9	43.8	
Effective Green, g (s)	10.5	10.5		10.5	10.5		69.5	61.4		46.9	43.8	
Actuated g/C Ratio	0.12	0.12		0.12	0.12		0.77	0.68		0.52	0.49	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	157	194		84	212		1033	2403		585	1667	
v/s Ratio Prot		0.04			0.01		c0.16	0.09		0.00	0.06	
v/s Ratio Perm	c0.04			0.02			c0.38			0.01		
v/c Ratio	0.34	0.30		0.13	0.12		0.70	0.13		0.02	0.12	
Uniform Delay, d1	36.6	36.4		35.7	35.6		6.3	5.0		10.4	12.6	
Progression Factor	1.00	1.00		1.00	1.00		0.51	0.88		1.00	1.00	
Incremental Delay, d2	1.3	0.9		0.7	0.2		1.8	0.1		0.0	0.1	
Delay (s)	37.8	37.3		36.4	35.8		5.0	4.5		10.4	12.7	
Level of Service	D	D		D	D		A	A		B	B	
Approach Delay (s)		37.4			35.9			4.9			12.6	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM Average Control Delay	15.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	79.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

2: US 56 & Gardner Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↑	↱	↰	↑↑	↱	↰↰	↑↱	
Volume (vph)	180	490	50	320	920	400	50	860	220	320	910	150
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3519	1583	1770	3654	1583	1770	3689	1568	3400	3435	
Flt Permitted	0.16	1.00	1.00	0.35	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	297	3519	1583	649	3654	1583	1770	3689	1568	3400	3435	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	189	516	53	337	968	421	53	905	232	337	958	158
RTOR Reduction (vph)	0	0	38	0	0	233	0	0	156	0	14	0
Lane Group Flow (vph)	189	516	15	337	968	188	53	905	76	337	1102	0
Heavy Vehicles (%)	2%	8%	2%	2%	4%	2%	2%	3%	3%	3%	3%	2%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			
Actuated Green, G (s)	32.3	25.1	25.1	33.7	25.8	25.8	3.9	29.0	29.0	11.3	36.4	
Effective Green, g (s)	32.3	25.1	25.1	33.7	25.8	25.8	3.9	29.0	29.0	11.3	36.4	
Actuated g/C Ratio	0.36	0.28	0.28	0.37	0.29	0.29	0.04	0.32	0.32	0.13	0.40	
Clearance Time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	224	981	441	341	1047	454	77	1189	505	427	1389	
v/s Ratio Prot	0.07	0.15		c0.09	0.26		c0.03	0.25		0.10	c0.32	
v/s Ratio Perm	0.23		0.01	c0.28		0.12			0.05			
v/c Ratio	0.84	0.53	0.03	0.99	0.92	0.42	0.69	0.76	0.15	0.79	0.79	
Uniform Delay, d1	23.0	27.4	23.6	25.9	31.2	26.0	42.5	27.4	21.7	38.2	23.5	
Progression Factor	1.33	0.66	0.39	1.33	1.15	1.93	0.74	0.56	0.30	1.00	1.00	
Incremental Delay, d2	23.6	2.0	0.1	37.1	11.0	1.9	14.2	1.8	0.1	9.4	3.2	
Delay (s)	54.4	20.0	9.3	71.6	46.9	52.1	45.5	17.1	6.7	47.6	26.7	
Level of Service	D	B	A	E	D	D	D	B	A	D	C	
Approach Delay (s)		27.8			53.0			16.3			31.5	
Approach LOS		C			D			B			C	

Intersection Summary			
HCM Average Control Delay	34.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	13.3
Intersection Capacity Utilization	83.8%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

3: US 56 & Elm

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱			↰↑↱		↰	↱		↰	↱	
Volume (vph)	10	1020	30	40	1640	40	20	10	50	100	20	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			1.00		1.00	0.88		1.00	0.91	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3425			3489		1719	1637		1770	1697	
Flt Permitted		0.93			0.89		0.72	1.00		0.72	1.00	
Satd. Flow (perm)		3176			3120		1307	1637		1332	1697	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	11	1074	32	42	1726	42	21	11	53	105	21	32
RTOR Reduction (vph)	0	1	0	0	1	0	0	47	0	0	24	0
Lane Group Flow (vph)	0	1116	0	0	1809	0	21	17	0	105	29	0
Heavy Vehicles (%)	0%	5%	3%	3%	3%	3%	5%	0%	2%	2%	0%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		70.0			70.0		11.0	11.0		11.0	11.0	
Effective Green, g (s)		70.0			70.0		11.0	11.0		11.0	11.0	
Actuated g/C Ratio		0.78			0.78		0.12	0.12		0.12	0.12	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2470			2427		160	200		163	207	
v/s Ratio Prot								0.01			0.02	
v/s Ratio Perm		0.35			c0.58		0.02			c0.08		
v/c Ratio		0.45			0.75		0.13	0.09		0.64	0.14	
Uniform Delay, d1		3.4			5.3		35.2	35.0		37.6	35.3	
Progression Factor		0.44			1.23		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.5			1.5		0.4	0.2		8.4	0.3	
Delay (s)		2.0			8.0		35.6	35.2		46.1	35.6	
Level of Service		A			A		D	D		D	D	
Approach Delay (s)		2.0			8.0			35.3			42.6	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	8.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	95.1%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

4: US 56 & Mulberry

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱			↰↑↱		↰	↱		↰	↱	
Volume (vph)	20	1150	10	30	1750	40	10	5	20	40	10	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		1.00			1.00		1.00	0.88		1.00	0.90	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3435			3490		1805	1605		1752	1713	
Flt Permitted		0.89			0.91		0.74	1.00		0.74	1.00	
Satd. Flow (perm)		3045			3176		1399	1605		1366	1713	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	1211	11	32	1842	42	11	5	21	42	11	21
RTOR Reduction (vph)	0	1	0	0	1	0	0	19	0	0	19	0
Lane Group Flow (vph)	0	1242	0	0	1915	0	11	7	0	42	13	0
Heavy Vehicles (%)	0%	5%	0%	3%	3%	3%	0%	0%	5%	3%	0%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		73.8			73.8		7.2	7.2		7.2	7.2	
Effective Green, g (s)		73.8			73.8		7.2	7.2		7.2	7.2	
Actuated g/C Ratio		0.82			0.82		0.08	0.08		0.08	0.08	
Clearance Time (s)		5.0			5.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		2497			2604		112	128		109	137	
v/s Ratio Prot								0.00			0.01	
v/s Ratio Perm		0.41			c0.60		0.01			c0.03		
v/c Ratio		0.50			0.74		0.10	0.05		0.39	0.09	
Uniform Delay, d1		2.5			3.7		38.4	38.2		39.3	38.4	
Progression Factor		0.38			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.7			1.1		0.4	0.2		2.3	0.3	
Delay (s)		1.6			4.8		38.8	38.4		41.6	38.7	
Level of Service		A			A		D	D		D	D	
Approach Delay (s)		1.6			4.8			38.5			40.3	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	4.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	87.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

2030 Gardner IMF Operations + Induced Development - (Improved + Mitigated) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

5: US 56 & Moonlight Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	150	800	250	380	1510	1280	200	550	160	730	720	180
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1736	3585	1583	1770	3689	1583	1770	3725	1583	3433	3539	1553
Flt Permitted	0.10	1.00	1.00	0.16	1.00	1.00	0.28	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	177	3585	1583	296	3689	1583	514	3725	1583	3433	3539	1553
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	158	842	263	400	1589	1347	211	579	168	768	758	189
RTOR Reduction (vph)	0	0	119	0	0	227	0	0	116	0	0	93
Lane Group Flow (vph)	158	842	144	400	1589	1120	211	579	52	768	758	96
Heavy Vehicles (%)	4%	6%	2%	2%	3%	2%	2%	2%	2%	2%	2%	4%
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		custom	Prot		Perm
Protected Phases	5	2		1	6		3	8	8	7	4	
Permitted Phases	2		2	6		6	8		8			4
Actuated Green, G (s)	47.4	41.4	41.4	69.5	58.0	58.0	23.0	14.5	14.5	18.5	24.5	24.5
Effective Green, g (s)	47.4	41.4	41.4	69.5	58.0	58.0	23.0	14.5	14.5	18.5	24.5	24.5
Actuated g/C Ratio	0.39	0.34	0.34	0.58	0.48	0.48	0.19	0.12	0.12	0.15	0.20	0.20
Clearance Time (s)	5.5	6.5	6.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	5.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	148	1237	546	449	1783	765	187	450	191	529	723	317
v/s Ratio Prot	0.05	0.23		c0.17	0.43		0.08	c0.16	0.03	c0.22	0.21	
v/s Ratio Perm	0.37		0.09	0.35		c0.71	0.14					0.06
v/c Ratio	1.07	0.68	0.26	0.89	0.89	1.46	1.13	1.29	0.27	1.45	1.05	0.30
Uniform Delay, d1	31.8	33.6	28.3	26.5	28.1	31.0	46.8	52.8	48.0	50.7	47.8	40.5
Progression Factor	1.00	1.00	1.00	0.91	0.99	1.02	0.90	0.95	0.95	1.00	1.00	1.00
Incremental Delay, d2	93.1	3.0	1.2	5.8	2.0	210.8	101.2	143.5	0.3	213.7	46.9	0.2
Delay (s)	124.9	36.7	29.5	29.9	29.8	242.3	143.4	193.8	45.9	264.5	94.6	40.7
Level of Service	F	D	C	C	C	F	F	F	D	F	F	D
Approach Delay (s)		46.2			115.7			156.8			164.7	
Approach LOS		D			F			F			F	

Intersection Summary			
HCM Average Control Delay	120.6	HCM Level of Service	F
HCM Volume to Capacity ratio	1.43		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	116.6%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

6: Old US 56 & US 56 — PM Peak Hour

Movement	NBL	NBR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	730	150	1380	310	10	2440
Ideal Flow (vphpl)	1900	1900	2000	1900	1900	2000
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	0.97	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	3433	1599	3654	1568	1805	3725
Flt Permitted	0.95	1.00	1.00	1.00	0.11	1.00
Satd. Flow (perm)	3433	1599	3654	1568	213	3725
Peak-hour factor, PHF	0.97	0.97	0.95	0.95	0.95	0.95
Adj. Flow (vph)	753	155	1453	326	11	2568
RTOR Reduction (vph)	0	78	0	43	0	0
Lane Group Flow (vph)	753	78	1453	283	11	2568
Heavy Vehicles (%)	2%	1%	4%	3%	0%	2%
Turn Type		Perm		pm+ov	pm+pt	
Protected Phases	8		2	8	1	6
Permitted Phases		8	2	2	6	6
Actuated Green, G (s)	27.0	27.0	77.2	104.2	83.0	83.0
Effective Green, g (s)	27.0	27.0	77.2	104.2	83.0	83.0
Actuated g/C Ratio	0.22	0.22	0.64	0.87	0.69	0.69
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	772	360	2351	1427	158	2576
v/s Ratio Prot	c0.22		0.40	0.04	0.00	c0.69
v/s Ratio Perm		0.05		0.14	0.05	
v/c Ratio	0.98	0.22	0.62	0.20	0.07	1.00
Uniform Delay, d1	46.2	37.9	12.7	1.3	10.0	18.4
Progression Factor	1.00	1.00	0.21	1.23	0.70	0.54
Incremental Delay, d2	26.2	0.3	0.1	0.0	0.1	13.1
Delay (s)	72.3	38.2	2.8	1.6	7.2	23.0
Level of Service	E	D	A	A	A	C
Approach Delay (s)	66.5		2.6			23.0
Approach LOS	E		A			C

Intersection Summary			
HCM Average Control Delay	23.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	93.2%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

7: US-56 & Cedar Niles — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	60	2110	190	780	1990	60	210	20	860	60	20	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2	5.2	5.2	5.2	5.2
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00	1.00	1.00	0.88	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3689	1583	3433	3689	1583	1770	2000	2787	1770	2000	1568
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.74	1.00	1.00	0.74	1.00	1.00
Satd. Flow (perm)	1770	3689	1583	3433	3689	1583	1385	2000	2787	1385	2000	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	63	2221	200	821	2095	63	221	21	905	63	21	42
RTOR Reduction (vph)	0	0	77	0	0	18	0	0	0	0	0	38
Lane Group Flow (vph)	63	2221	123	821	2095	45	221	21	905	63	21	4
Heavy Vehicles (%)	2%	3%	2%	2%	3%	2%	2%	0%	2%	2%	0%	3%
Turn Type	Prot		Perm	Prot		Perm	Perm		pt+ov	Perm		Perm
Protected Phases	5	2		1	6			8	8 1		4	
Permitted Phases			2			6	8			4		4
Actuated Green, G (s)	5.6	68.8	68.8	23.0	86.2	86.2	12.6	12.6	40.8	12.6	12.6	12.6
Effective Green, g (s)	5.6	68.8	68.8	23.0	86.2	86.2	12.6	12.6	40.8	12.6	12.6	12.6
Actuated g/C Ratio	0.05	0.57	0.57	0.19	0.72	0.72	0.10	0.10	0.34	0.10	0.10	0.10
Clearance Time (s)	4.0	6.4	6.4	4.0	6.4	6.4	5.2	5.2		5.2	5.2	5.2
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lane Grp Cap (vph)	83	2115	908	658	2650	1137	145	210	948	145	210	165
v/s Ratio Prot	0.04	c0.60		c0.24	0.57			0.01	0.32		0.01	
v/s Ratio Perm			0.08			0.03	c0.16			0.05		0.00
v/c Ratio	0.76	1.05	0.14	1.25	0.79	0.04	1.52	0.10	0.95	0.43	0.10	0.03
Uniform Delay, d1	56.5	25.6	11.8	48.5	11.0	4.9	53.7	48.6	38.7	50.4	48.6	48.2
Progression Factor	0.79	0.57	0.26	1.08	1.01	1.07	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	27.8	33.8	0.3	112.7	0.2	0.0	267.7	0.1	18.9	0.8	0.1	0.0
Delay (s)	72.2	48.4	3.4	165.0	11.3	5.2	321.4	48.6	57.6	51.1	48.6	48.2
Level of Service	E	D	A	F	B	A	F	D	E	D	D	D
Approach Delay (s)		45.4			53.5			108.2			49.7	
Approach LOS		D			D			F			D	

Intersection Summary			
HCM Average Control Delay	59.8	HCM Level of Service	E
HCM Volume to Capacity ratio	1.15		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.6
Intersection Capacity Utilization	109.0%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

8: US-56 & I-35 SB Ramps — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	2720	280	650	1250	0	0	0	0	150	0	1550
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		0.99		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3486		1736	3725					1770		2760
Flt Permitted		1.00		0.23	1.00					0.95		1.00
Satd. Flow (perm)		3486		418	3725					1770		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2863	295	684	1316	0	0	0	0	158	0	1632
RTOR Reduction (vph)	0	7	0	0	0	0	0	0	0	0	0	7
Lane Group Flow (vph)	0	3152	0	684	1316	0	0	0	0	158	0	1625
Heavy Vehicles (%)	0%	2%	3%	4%	2%	0%	0%	0%	0%	2%	0%	3%
Turn Type				pm+pt						custom		custom
Protected Phases		2		1	6					4		5
Permitted Phases				6						4		4
Actuated Green, G (s)		68.0		44.5	44.5					10.0		60.5
Effective Green, g (s)		68.0		44.5	44.5					10.0		60.5
Actuated g/C Ratio		0.57		0.37	0.37					0.08		0.50
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		1975		452	1381					148		1507
v/s Ratio Prot		c0.90		c0.34	0.35					0.09		c0.45
v/s Ratio Perm				0.22								0.13
v/c Ratio		1.60		1.51	0.95					1.07		1.08
Uniform Delay, d1		26.0		34.3	36.7					55.0		29.8
Progression Factor		0.82		0.94	0.90					1.00		1.00
Incremental Delay, d2		268.3		238.7	10.9					93.1		47.3
Delay (s)		289.7		270.8	43.9					148.1		77.1
Level of Service		F		F	D					F		E
Approach Delay (s)		289.7			121.5			0.0			83.4	
Approach LOS		F			F			A			F	

Intersection Summary			
HCM Average Control Delay	188.1	HCM Level of Service	F
HCM Volume to Capacity ratio	1.49		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	140.1%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)
9: US-56 & I-35 NB Ramps — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑			↑↑	↱	↰	↱	↱			
Volume (vph)	0	1550	0	0	1800	570	100	0	400	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95	0.95			
Frt		1.00			1.00	0.85	1.00	0.85	0.85			
Flt Protected		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (prot)		3725			3539	1538	1703	1408	1408			
Flt Permitted		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (perm)		3725			3539	1538	1703	1408	1408			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1632	0	0	1895	600	105	0	421	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	82	0	0	0	0	0	0
Lane Group Flow (vph)	0	1632	0	0	1895	518	105	211	210	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	5%	6%	0%	9%	0%	0%	0%
Turn Type						Perm	Perm		Perm			
Protected Phases		2			6			8				
Permitted Phases						6	8		8			
Actuated Green, G (s)		86.2			86.2	86.2	23.8	23.8	23.8			
Effective Green, g (s)		86.2			86.2	86.2	23.8	23.8	23.8			
Actuated g/C Ratio		0.72			0.72	0.72	0.20	0.20	0.20			
Clearance Time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0	3.0			
Lane Grp Cap (vph)		2676			2542	1105	338	279	279			
v/s Ratio Prot		0.44			c0.54			c0.15				
v/s Ratio Perm						0.34	0.06		0.15			
v/c Ratio		0.61			0.75	0.47	0.31	0.76	0.75			
Uniform Delay, d1		8.5			10.2	7.2	41.1	45.4	45.3			
Progression Factor		0.38			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2		0.1			1.2	0.3	0.5	11.1	10.9			
Delay (s)		3.3			11.5	7.5	41.6	56.5	56.2			
Level of Service		A			B	A	D	E	E			
Approach Delay (s)		3.3			10.5			53.4			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	12.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	85.1%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)
10: Santa Fe & Moonlight Road — PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰	↱	↑↱		↰	↑↑
Volume (vph)	240	480	440	160	380	940
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.96		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1583	3398		1770	3539
Flt Permitted	0.95	1.00	1.00		0.38	1.00
Satd. Flow (perm)	1770	1583	3398		700	3539
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	253	505	463	168	400	989
RTOR Reduction (vph)	0	407	18	0	0	0
Lane Group Flow (vph)	253	98	613	0	400	989
Turn Type		Perm			pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8			6	
Actuated Green, G (s)	23.2	23.2	68.9		86.8	86.8
Effective Green, g (s)	23.2	23.2	68.9		86.8	86.8
Actuated g/C Ratio	0.19	0.19	0.57		0.72	0.72
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	342	306	1951		621	2560
v/s Ratio Prot	c0.14		0.18		c0.07	0.28
v/s Ratio Perm		0.06			c0.40	
v/c Ratio	0.74	0.32	0.31		0.64	0.39
Uniform Delay, d1	45.6	41.6	13.3		13.7	6.4
Progression Factor	1.00	1.00	1.00		1.56	1.85
Incremental Delay, d2	8.1	0.6	0.4		1.1	0.2
Delay (s)	53.7	42.2	13.7		22.6	12.0
Level of Service	D	D	B		C	B
Approach Delay (s)	46.0		13.7			15.1
Approach LOS	D		B			B

Intersection Summary			
HCM Average Control Delay	23.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)
11: Waverly Road & US 56 — PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰	↑↑	↱	↰↰	↑↱		↰	↑↑	↱	↰	↑↑	↱
Volume (vph)	20	330	170	300	230	30	40	90	20	180	150	600
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95		1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.98		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1805	3539	1524	3400	3457		1752	3167	1615	1671	3374	1568
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1805	3539	1524	3400	3457		1752	3167	1615	1671	3374	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	347	179	316	242	32	42	95	21	189	158	632
RTOR Reduction (vph)	0	0	151	0	13	0	0	0	17	0	0	393
Lane Group Flow (vph)	21	347	28	316	261	0	42	95	4	189	158	239
Heavy Vehicles (%)	0%	2%	6%	3%	2%	7%	3%	14%	0%	8%	7%	3%
Turn Type	Prot		Perm	Prot			Prot		Perm	Prot		Perm
Protected Phases	3	8		7	4		5	2		1	6	
Permitted Phases			8					2	2			6
Actuated Green, G (s)	2.2	14.0	14.0	16.6	28.4		5.3	16.5	16.5	22.9	34.1	34.1
Effective Green, g (s)	2.2	14.0	14.0	16.6	28.4		5.3	16.5	16.5	22.9	34.1	34.1
Actuated g/C Ratio	0.02	0.16	0.16	0.18	0.32		0.06	0.18	0.18	0.25	0.38	0.38
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	44	551	237	627	1091		103	581	296	425	1278	594
v/s Ratio Prot	0.01	c0.10		c0.09	0.08		0.02	0.03		c0.11	0.05	
v/s Ratio Perm			0.02						0.00			c0.15
v/c Ratio	0.48	0.63	0.12	0.50	0.24		0.41	0.16	0.01	0.44	0.12	0.40
Uniform Delay, d1	43.3	35.6	32.7	33.0	22.8		40.8	30.9	30.1	28.2	18.2	20.5
Progression Factor	1.00	1.00	1.00	0.89	0.85		1.07	0.91	0.74	1.58	0.35	2.27
Incremental Delay, d2	7.9	2.3	0.2	0.6	0.1		2.6	0.6	0.1	0.4	0.1	1.0
Delay (s)	51.3	37.8	32.9	29.9	19.5		46.1	28.8	22.5	44.9	6.4	47.4
Level of Service	D	D	C	C	B		D	C	C	D	A	D
Approach Delay (s)		36.7			25.1			32.6			40.3	
Approach LOS		D			C			C			D	

Intersection Summary			
HCM Average Control Delay	35.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	62.1%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)
12: 183rd Street & Four Corners Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✥			✥			✥			✥	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	50	5	0	30	5	5	50	0	5	20	5
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	53	5	0	32	5	5	53	0	5	21	5

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	63	37	58	32
Volume Left (vph)	5	0	5	5
Volume Right (vph)	5	5	0	5
Hadj (s)	0.00	-0.04	0.05	-0.01
Departure Headway (s)	4.1	4.1	4.2	4.2
Degree Utilization, x	0.07	0.04	0.07	0.04
Capacity (veh/h)	848	849	827	838
Control Delay (s)	7.5	7.3	7.5	7.3
Approach Delay (s)	7.5	7.3	7.5	7.3
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.4		
HCM Level of Service	A		
Intersection Capacity Utilization	17.2%	ICU Level of Service	A
Analysis Period (min)	15		

13: 183rd Street & US 56

PM Peak Hour

Intersection Sign configuration not allowed in HCM analysis.

14: 183rd Street & Waverly Road

PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	10	280	190	10	190	230
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	11	295	200	11	200	242
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	847	205			211	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	847	205			211	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	96	65			85	
cM capacity (veh/h)	286	840			1372	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	305	211	442
Volume Left	11	0	200
Volume Right	295	11	0
cSH	788	1700	1372
Volume to Capacity	0.39	0.12	0.15
Queue Length 95th (ft)	46	0	13
Control Delay (s)	12.4	0.0	4.4
Lane LOS	B		A
Approach Delay (s)	12.4	0.0	4.4
Approach LOS	B		

Intersection Summary			
Average Delay	6.0		
Intersection Capacity Utilization	61.1%	ICU Level of Service	B
Analysis Period (min)	15		

15: 183rd Street & Gardner Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	130	140	170	170	140	90	220	950	280	130	940	120
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.92		1.00	0.94		1.00	0.97		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1726		1770	1764		1805	3393		1770	3449	
Flt Permitted	0.52	1.00		0.21	1.00		0.18	1.00		0.11	1.00	
Satd. Flow (perm)	964	1726		384	1764		350	3393		213	3449	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	147	179	179	147	95	232	1000	295	137	989	126
RTOR Reduction (vph)	0	49	0	0	0	0	0	31	0	0	11	0
Lane Group Flow (vph)	137	277	0	179	242	0	232	1264	0	137	1104	0
Heavy Vehicles (%)	2%	1%	1%	2%	1%	2%	0%	3%	2%	2%	3%	2%
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	21.8	15.8		29.0	19.4		40.0	40.0		39.6	39.6	
Effective Green, g (s)	21.8	15.8		29.0	19.4		40.0	40.0		39.6	39.6	
Actuated g/C Ratio	0.24	0.18		0.32	0.22		0.44	0.44		0.44	0.44	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	287	303		272	380		236	1508		173	1518	
v/s Ratio Prot	0.03	c0.16		c0.07	0.14		0.05	c0.37		0.04	c0.32	
v/s Ratio Perm	0.08			0.14			c0.38			0.31		
v/c Ratio	0.48	0.92		0.66	0.64		0.98	0.84		0.79	0.73	
Uniform Delay, d1	28.0	36.4		24.4	32.1		29.2	22.1		20.9	20.8	
Progression Factor	1.15	1.09		1.00	1.00		1.00	1.00		0.80	0.85	
Incremental Delay, d2	1.3	30.5		5.7	3.5		53.5	5.7		13.4	1.8	
Delay (s)	33.5	70.4		30.0	35.6		82.7	27.9		30.1	19.5	
Level of Service	C	E		C	D		F	C		C	B	
Approach Delay (s)		59.5			33.2			36.2			20.6	
Approach LOS		E			C			D			C	

Intersection Summary			
HCM Average Control Delay	33.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	25.0
Intersection Capacity Utilization	86.3%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

16: Four Corners Road & US 56

PM Peak Hour

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Volume (veh/h)	0	20	50	130	160	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	0	21	53	137	168	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	411	168	168			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	411	168	168			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	98	96			
cM capacity (veh/h)	579	881	1409			

Direction, Lane #	SB 1	NE 1	SW 1
Volume Total	21	189	168
Volume Left	0	53	0
Volume Right	21	0	0
cSH	881	1409	1700
Volume to Capacity	0.02	0.04	0.10
Queue Length 95th (ft)	2	3	0
Control Delay (s)	9.2	2.4	0.0
Lane LOS	A	A	
Approach Delay (s)	9.2	2.4	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	31.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

17: 191st Street & US 56 — PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	50	5	5	120	170	30
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	53	5	5	126	179	32
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	332	195	211			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	332	195	211			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	92	99	100			
cM capacity (veh/h)	661	852	1372			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	58	132	211
Volume Left	53	5	0
Volume Right	5	0	32
cSH	674	1372	1700
Volume to Capacity	0.09	0.00	0.12
Queue Length 95th (ft)	7	0	0
Control Delay (s)	10.8	0.3	0.0
Lane LOS	B	A	
Approach Delay (s)	10.8	0.3	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	20.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

18: 191st Street & Four Corners Road — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	20	30	120	40	20	120
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.95	0.92	0.92	0.95
Hourly flow rate (vph)	22	33	126	43	22	126
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			54		334	38
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			54		334	38
tC, single (s)			5.0		6.7	7.2
tC, 2 stage (s)						
tF (s)			3.0		3.8	4.2
p0 queue free %			89		96	84
cM capacity (veh/h)			1124		532	812

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	54	170	148
Volume Left	0	126	22
Volume Right	33	0	126
cSH	1700	1124	754
Volume to Capacity	0.03	0.11	0.20
Queue Length 95th (ft)	0	9	18
Control Delay (s)	0.0	6.7	10.9
Lane LOS		A	B
Approach Delay (s)	0.0	6.7	10.9
Approach LOS			B

Intersection Summary			
Average Delay	7.4		
Intersection Capacity Utilization	30.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

19: 191st Street & Waverly Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	130	120	70	30	130	20	90	50	10	20	100	120
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	137	126	74	32	137	21	95	53	11	21	105	126

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	337	189	158	253
Volume Left (vph)	137	32	95	21
Volume Right (vph)	74	21	11	126
Hadj (s)	0.23	-0.01	1.01	-0.22
Departure Headway (s)	5.8	5.8	7.0	5.6
Degree Utilization, x	0.54	0.31	0.31	0.39
Capacity (veh/h)	588	558	462	584
Control Delay (s)	15.3	11.4	13.0	12.2
Approach Delay (s)	15.3	11.4	13.0	12.2
Approach LOS	C	B	B	B

Intersection Summary			
Delay	13.3		
HCM Level of Service	B		
Intersection Capacity Utilization	62.8%	ICU Level of Service	B
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

20: W 191st Street & Gardner Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	110	30	310	270	30	290	280	1410	240	240	1120	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)	5.0	5.0	5.0	2.5	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.86		1.00	0.98		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1770	1845	1583	1770	1608		1770	3582		1770	3689	1524
Flt Permitted	0.29	1.00	1.00	0.72	1.00		0.12	1.00		0.08	1.00	1.00
Satd. Flow (perm)	548	1845	1583	1341	1608		222	3582		141	3689	1524
Peak-hour factor, PHF	0.95	0.92	0.95	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	116	33	326	293	33	315	295	1484	261	261	1179	105
RTOR Reduction (vph)	0	0	260	0	206	0	0	13	0	0	0	48
Lane Group Flow (vph)	116	33	66	293	142	0	295	1732	0	261	1179	57
Heavy Vehicles (%)	2%	3%	2%	2%	3%	2%	2%	4%	2%	2%	3%	6%
Turn Type	pm+pt		Perm	pm+pt			pm+pt			pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8			2			6		6
Actuated Green, G (s)	19.3	13.6	13.6	22.4	13.9		73.6	56.1		67.2	52.9	52.9
Effective Green, g (s)	19.3	13.6	13.6	22.4	13.9		73.6	56.1		67.2	52.9	52.9
Actuated g/C Ratio	0.18	0.12	0.12	0.20	0.13		0.67	0.51		0.61	0.48	0.48
Clearance Time (s)	5.0	5.0	5.0	2.5	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	159	228	196	306	203		395	1827		298	1774	733
v/s Ratio Prot	0.04	0.02		c0.07	0.09		c0.12	c0.48		0.11	0.32	
v/s Ratio Perm	0.09		0.04	c0.12			0.38			0.42		0.04
v/c Ratio	0.73	0.14	0.34	0.96	0.70		0.75	0.95		0.88	0.66	0.08
Uniform Delay, d1	41.3	43.0	44.1	42.6	46.0		21.9	25.6		33.4	21.8	15.4
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.15	0.77		1.00	1.00	1.00
Incremental Delay, d2	15.4	0.3	1.0	39.7	10.0		5.4	9.2		23.7	1.0	0.0
Delay (s)	56.7	43.3	45.1	82.3	56.1		30.7	28.8		57.1	22.7	15.4
Level of Service	E	D	D	F	E		C	C		E	C	B
Approach Delay (s)		47.8			68.1			29.1			28.0	
Approach LOS		D			E			C			C	

Intersection Summary			
HCM Average Control Delay	35.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	99.8%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

21: I-35 SB Ramps & Gardner Rd

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	380	0	1190	30	740	0	0	1310	390
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)				5.0	5.0	2.5	2.5	5.0			5.0	
Lane Util. Factor				1.00	0.95	0.95	1.00	0.95			0.95	
Frt				1.00	0.85	0.85	1.00	1.00			0.97	
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1752	1475	1475	1687	3725			3562	
Flt Permitted				0.95	1.00	1.00	0.12	1.00			1.00	
Satd. Flow (perm)				1752	1475	1475	205	3725			3562	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	400	0	1253	32	779	0	0	1379	411
RTOR Reduction (vph)	0	0	0	0	386	14	0	0	0	0	23	0
Lane Group Flow (vph)	0	0	0	400	241	612	32	779	0	0	1767	0
Heavy Vehicles (%)	0%	0%	0%	3%	0%	4%	7%	2%	0%	0%	3%	3%
Turn Type				custom		custom	pm+pt					
Protected Phases				8	8	1	5	2			6	
Permitted Phases				8		8	2					
Actuated Green, G (s)				28.9	28.9	62.9	37.9	34.6			65.3	
Effective Green, g (s)				28.9	28.9	62.9	37.9	34.6			65.3	
Actuated g/C Ratio				0.26	0.26	0.57	0.34	0.31			0.59	
Clearance Time (s)				5.0	5.0	2.5	2.5	5.0			5.0	
Vehicle Extension (s)				3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)				460	388	877	115	1172			2115	
v/s Ratio Prot				c0.23	0.16	c0.22	0.01	0.21			c0.50	
v/s Ratio Perm						0.20	0.09					
v/c Ratio				0.87	0.62	0.70	0.28	0.66			0.84	
Uniform Delay, d1				38.7	35.7	16.8	48.8	32.7			18.0	
Progression Factor				1.00	1.00	1.00	1.36	0.56			0.57	
Incremental Delay, d2				15.9	3.1	2.4	0.8	1.9			2.9	
Delay (s)				54.7	38.8	19.2	67.3	20.3			13.2	
Level of Service				D	D	B	E	C			B	
Approach Delay (s)		0.0			35.2			22.1			13.2	
Approach LOS		A			D			C			B	

Intersection Summary			
HCM Average Control Delay	23.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	85.8%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

22: I-35 NB Ramps & Gardner Rd

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	180	0	20	0	0	0	0	600	250	840	850	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	2000	1900	1900	2000	1900
Total Lost time (s)		5.0						5.0	5.0	5.0	5.0	
Lane Util. Factor		1.00						1.00	1.00	0.97	0.95	
Frt		0.99						1.00	0.85	1.00	1.00	
Flt Protected		0.96						1.00	1.00	0.95	1.00	
Satd. Flow (prot)		1694						1961	1568	3367	3725	
Flt Permitted		0.96						1.00	1.00	0.95	1.00	
Satd. Flow (perm)		1694						1961	1568	3367	3725	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	189	0	21	0	0	0	0	632	263	884	895	0
RTOR Reduction (vph)	0	3	0	0	0	0	0	0	152	0	0	0
Lane Group Flow (vph)	0	207	0	0	0	0	0	632	111	884	895	0
Heavy Vehicles (%)	6%	0%	5%	0%	0%	0%	0%	2%	3%	4%	2%	0%
Turn Type	Split								Perm	Prot		
Protected Phases	4	4						2		1	6	
Permitted Phases									2			
Actuated Green, G (s)		16.5						46.5	46.5	32.0	83.5	
Effective Green, g (s)		16.5						46.5	46.5	32.0	83.5	
Actuated g/C Ratio		0.15						0.42	0.42	0.29	0.76	
Clearance Time (s)		5.0						5.0	5.0	5.0	5.0	
Vehicle Extension (s)		3.0						3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)		254						829	663	979	2828	
v/s Ratio Prot		c0.12						c0.32		c0.26	0.24	
v/s Ratio Perm									0.07			
v/c Ratio		0.81						0.76	0.17	0.90	0.32	
Uniform Delay, d1		45.3						27.0	19.7	37.5	4.2	
Progression Factor		1.00						0.93	1.34	0.90	0.72	
Incremental Delay, d2		17.7						5.8	0.5	6.7	0.2	
Delay (s)		63.0						31.1	26.9	40.6	3.2	
Level of Service		E						C	C	D	A	
Approach Delay (s)		63.0			0.0			29.8			21.8	
Approach LOS		E			A			C			C	

Intersection Summary			
HCM Average Control Delay	27.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	85.8%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

23: E 191st Street & Gardner Rd

PM Peak Hour

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	30	140	710	20	60	810
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		5.0			5.0
Lane Util. Factor	1.00		1.00			1.00
Frt	0.89		1.00			1.00
Flt Protected	0.99		1.00			1.00
Satd. Flow (prot)	1613		1857			1850
Flt Permitted	0.99		1.00			0.91
Satd. Flow (perm)	1613		1857			1682
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	32	147	747	21	63	853
RTOR Reduction (vph)	135	0	1	0	0	0
Lane Group Flow (vph)	44	0	767	0	0	916
Heavy Vehicles (%)	3%	4%	2%	0%	7%	2%
Turn Type					Perm	
Protected Phases	8		2			6
Permitted Phases					6	
Actuated Green, G (s)	8.9		91.1			91.1
Effective Green, g (s)	8.9		91.1			91.1
Actuated g/C Ratio	0.08		0.83			0.83
Clearance Time (s)	5.0		5.0			5.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	131		1538			1393
v/s Ratio Prot	c0.03		0.41			
v/s Ratio Perm						c0.54
v/c Ratio	0.34		0.50			0.66
Uniform Delay, d1	47.8		2.8			3.6
Progression Factor	1.00		1.00			1.23
Incremental Delay, d2	1.5		0.3			2.4
Delay (s)	49.3		3.0			6.7
Level of Service	D		A			A
Approach Delay (s)	49.3		3.0			6.7
Approach LOS	D		A			A

Intersection Summary			
HCM Average Control Delay	9.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	107.3%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

24: Sunflower Road & US 56

PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	90	10	370	30	10	10	110	300	10	170	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.99			1.00			0.90			1.00	
Flt Protected		1.00			0.96			1.00			1.00	
Satd. Flow (prot)		1857			1764			1630			1805	
Flt Permitted		1.00			0.67			0.99			0.97	
Satd. Flow (perm)		1857			1241			1620			1763	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	95	11	389	32	11	11	116	316	11	179	5
RTOR Reduction (vph)	0	4	0	0	1	0	0	98	0	0	1	0
Lane Group Flow (vph)	0	102	0	0	431	0	0	345	0	0	194	0
Heavy Vehicles (%)	0%	1%	0%	3%	0%	0%	0%	9%	4%	0%	5%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		32.4			32.4			47.6			47.6	
Effective Green, g (s)		32.4			32.4			47.6			47.6	
Actuated g/C Ratio		0.36			0.36			0.53			0.53	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		669			447			857			932	
v/s Ratio Prot		0.05										
v/s Ratio Perm					c0.35			c0.21			0.11	
v/c Ratio		0.15			0.96			0.40			0.21	
Uniform Delay, d1		19.5			28.2			12.7			11.2	
Progression Factor		1.00			1.00			1.27			1.77	
Incremental Delay, d2		0.1			33.1			1.3			0.5	
Delay (s)		19.6			61.3			17.5			20.3	
Level of Service		B			E			B			C	
Approach Delay (s)		19.6			61.3			17.5			20.3	
Approach LOS		B			E			B			C	

Intersection Summary			
HCM Average Control Delay	34.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	65.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

25: US 56 & 4th Street — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	330	130	90	460	150	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0			5.0	5.0	
Lane Util. Factor	1.00			1.00	1.00	
Frt	0.96			1.00	0.95	
Flt Protected	1.00			0.99	0.97	
Satd. Flow (prot)	1755			1833	1715	
Flt Permitted	1.00			0.85	0.97	
Satd. Flow (perm)	1755			1577	1715	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	347	137	95	484	158	95
RTOR Reduction (vph)	13	0	0	0	27	0
Lane Group Flow (vph)	471	0	0	579	226	0
Heavy Vehicles (%)	5%	2%	2%	3%	2%	2%
Turn Type			Perm			
Protected Phases	4			8	2	
Permitted Phases			8			
Actuated Green, G (s)	63.1			63.1	16.9	
Effective Green, g (s)	63.1			63.1	16.9	
Actuated g/C Ratio	0.70			0.70	0.19	
Clearance Time (s)	5.0			5.0	5.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	1230			1106	322	
v/s Ratio Prot	0.27				c0.13	
v/s Ratio Perm				c0.37		
v/c Ratio	0.38			0.52	0.70	
Uniform Delay, d1	5.5			6.4	34.2	
Progression Factor	1.00			1.98	1.00	
Incremental Delay, d2	0.9			1.2	6.8	
Delay (s)	6.4			13.8	41.0	
Level of Service	A			B	D	
Approach Delay (s)	6.4			13.8	41.0	
Approach LOS	A			B	D	

Intersection Summary			
HCM Average Control Delay	16.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	80.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

26: 199th Street & Four Corners Road — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	10	400	420	130	140	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0		5.0	
Lane Util. Factor		1.00	1.00		1.00	
Frt		1.00	0.97		0.99	
Flt Protected		1.00	1.00		0.96	
Satd. Flow (prot)		1843	1480		1008	
Flt Permitted		0.99	1.00		0.96	
Satd. Flow (perm)		1819	1480		1008	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	11	421	442	137	147	11
RTOR Reduction (vph)	0	0	15	0	5	0
Lane Group Flow (vph)	0	432	564	0	153	0
Heavy Vehicles (%)	40%	2%	2%	96%	82%	30%
Turn Type	Perm					
Protected Phases		4	8		6	
Permitted Phases	4					
Actuated Green, G (s)		31.2	31.2		10.7	
Effective Green, g (s)		31.2	31.2		10.7	
Actuated g/C Ratio		0.60	0.60		0.21	
Clearance Time (s)		5.0	5.0		5.0	
Vehicle Extension (s)		3.0	3.0		3.0	
Lane Grp Cap (vph)		1094	890		208	
v/s Ratio Prot			c0.38		c0.15	
v/s Ratio Perm		0.24				
v/c Ratio		0.39	0.63		0.74	
Uniform Delay, d1		5.4	6.7		19.3	
Progression Factor		1.00	1.00		1.00	
Incremental Delay, d2		0.2	1.5		12.7	
Delay (s)		5.6	8.2		32.0	
Level of Service		A	A		C	
Approach Delay (s)		5.6	8.2		32.0	
Approach LOS		A	A		C	

Intersection Summary			
HCM Average Control Delay	10.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	51.9	Sum of lost time (s)	10.0
Intersection Capacity Utilization	46.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

27: 199th Street & Gardner Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	170	20	30	210	330	10	130	30	420	200	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00		1.00		1.00	1.00	1.00
Frt	1.00	0.98		1.00	1.00	0.85		0.98		1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		1.00		0.95	1.00	1.00
Satd. Flow (prot)	1805	1805		1752	1827	1583		1798		1770	1863	1568
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.98		0.53	1.00	1.00
Satd. Flow (perm)	1805	1805		1752	1827	1583		1768		995	1863	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	21	179	21	32	221	347	11	137	32	442	211	32
RTOR Reduction (vph)	0	5	0	0	0	275	0	8	0	0	0	13
Lane Group Flow (vph)	21	195	0	32	221	72	0	172	0	442	211	19
Heavy Vehicles (%)	0%	4%	0%	3%	4%	2%	0%	3%	3%	2%	2%	3%
Turn Type	Prot			Prot		Perm	Perm			pm+pt		Perm
Protected Phases	5	2		1	6			8		7	4	
Permitted Phases						6	8			4		4
Actuated Green, G (s)	3.1	15.4		6.5	18.8	18.8		31.9		53.1	53.1	53.1
Effective Green, g (s)	3.1	15.4		6.5	18.8	18.8		31.9		53.1	53.1	53.1
Actuated g/C Ratio	0.03	0.17		0.07	0.21	0.21		0.35		0.59	0.59	0.59
Clearance Time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	62	309		127	382	331		627		727	1099	925
v/s Ratio Prot	0.01	c0.11		0.02	c0.12					c0.11	0.11	
v/s Ratio Perm						0.05		0.10		c0.25		0.01
v/c Ratio	0.34	0.63		0.25	0.58	0.22		0.27		0.61	0.19	0.02
Uniform Delay, d1	42.4	34.7		39.5	32.0	29.5		20.8		10.9	8.5	7.7
Progression Factor	1.14	0.98		1.00	1.00	1.00		1.00		1.00	1.00	1.00
Incremental Delay, d2	3.2	4.2		1.0	2.1	0.3		1.1		1.4	0.4	0.0
Delay (s)	51.6	38.0		40.5	34.2	29.8		21.9		12.3	8.9	7.7
Level of Service	D	D		D	C	C		C		B	A	A
Approach Delay (s)		39.3			32.0			21.9			11.1	
Approach LOS		D			C			C			B	

Intersection Summary			
HCM Average Control Delay	23.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	63.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

28: I-35 SB Ramps & Sunflower Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	110	0	550	10	100	0	0	270	180
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)					5.0			5.0			5.0	
Lane Util. Factor					1.00			1.00			1.00	
Frt					0.89			1.00			0.95	
Flt Protected					0.99			1.00			1.00	
Satd. Flow (prot)					1640			1823			1745	
Flt Permitted					0.99			0.95			1.00	
Satd. Flow (perm)					1640			1744			1745	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	116	0	579	11	105	0	0	284	189
RTOR Reduction (vph)	0	0	0	0	127	0	0	0	0	0	51	0
Lane Group Flow (vph)	0	0	0	0	568	0	0	116	0	0	422	0
Heavy Vehicles (%)	0%	0%	0%	2%	0%	2%	20%	2%	0%	0%	3%	3%
Turn Type				custom			Perm					
Protected Phases				6	6			8			4	
Permitted Phases				6			8					
Actuated Green, G (s)					44.9			35.1			35.1	
Effective Green, g (s)					44.9			35.1			35.1	
Actuated g/C Ratio					0.50			0.39			0.39	
Clearance Time (s)					5.0			5.0			5.0	
Vehicle Extension (s)					3.0			3.0			3.0	
Lane Grp Cap (vph)					818			680			681	
v/s Ratio Prot					c0.35						c0.24	
v/s Ratio Perm								0.07				
v/c Ratio					0.69			0.17			0.62	
Uniform Delay, d1					17.3			17.9			22.1	
Progression Factor					1.00			0.33			1.00	
Incremental Delay, d2					2.6			0.5			4.2	
Delay (s)					19.9			6.4			26.3	
Level of Service					B			A			C	
Approach Delay (s)		0.0			19.9			6.4			26.3	
Approach LOS		A			B			A			C	

Intersection Summary			
HCM Average Control Delay	21.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	73.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)
29: I-35 NB Ramps & Sunflower Road PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	0	10	0	0	0	0	30	40	240	140	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.98						0.92			1.00	
Flt Protected		0.96						1.00			0.97	
Satd. Flow (prot)		1745						1637			1795	
Flt Permitted		0.96						1.00			0.76	
Satd. Flow (perm)		1745						1637			1414	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	84	0	11	0	0	0	0	32	42	253	147	0
RTOR Reduction (vph)	0	5	0	0	0	0	0	9	0	0	0	0
Lane Group Flow (vph)	0	90	0	0	0	0	0	65	0	0	400	0
Heavy Vehicles (%)	3%	0%	0%	0%	0%	0%	0%	10%	5%	3%	2%	0%
Turn Type	Perm									Perm		
Protected Phases		2						8			4	
Permitted Phases	2									4		
Actuated Green, G (s)		9.9						70.1			70.1	
Effective Green, g (s)		9.9						70.1			70.1	
Actuated g/C Ratio		0.11						0.78			0.78	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		192						1275			1101	
v/s Ratio Prot								0.04				
v/s Ratio Perm		0.05									c0.28	
v/c Ratio		0.47						0.05			0.36	
Uniform Delay, d1		37.6						2.3			3.1	
Progression Factor		1.00						1.00			1.81	
Incremental Delay, d2		1.8						0.1			0.8	
Delay (s)		39.4						2.4			6.4	
Level of Service		D						A			A	
Approach Delay (s)		39.4			0.0			2.4			6.4	
Approach LOS		D			A			A			A	

Intersection Summary			
HCM Average Control Delay	11.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	40.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)
30: US-56 & I-35 NB Loop PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	1550	1320	0	1900	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	1632	1389	0	2000	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				821		
pX, platoon unblocked					0.60	
vC, conflicting volume			3021		2632	816
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			3021		2388	816
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			115		18	324

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2
Volume Total	816	816	1389	1000	1000
Volume Left	0	0	0	0	0
Volume Right	0	0	1389	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.48	0.48	0.82	0.59	0.59
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					
Approach Delay (s)	0.0			0.0	
Approach LOS					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	85.1%	ICU Level of Service	E
Analysis Period (min)	15		

BNSF NEPA Traffic Study 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)
31: US 56 & Edgerton Rd PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	200	30	60	390	50	40	50	20	90	100	10
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Hourly flow rate (vph)	11	217	33	65	424	54	42	53	22	98	105	11

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	261	543	116	214
Volume Left (vph)	11	65	42	98
Volume Right (vph)	33	54	22	11
Hadj (s)	-0.02	0.07	0.22	0.10
Departure Headway (s)	6.0	5.6	7.0	6.6
Degree Utilization, x	0.44	0.85	0.23	0.39
Capacity (veh/h)	551	543	456	501
Control Delay (s)	13.6	32.2	12.1	13.9
Approach Delay (s)	13.6	32.2	12.1	13.9
Approach LOS	B	D	B	B

Intersection Summary			
Delay	22.4		
HCM Level of Service	C		
Intersection Capacity Utilization	65.2%	ICU Level of Service	C
Analysis Period (min)	15		

BNSF NEPA Traffic Study 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)
32: 207th & Sunflower Road PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	0	180	5	5	10	200	290	10	5	330	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	0	228	6	6	13	253	367	13	6	418	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1329	1320	421	1541	1316	373	424			380		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1329	1320	421	1541	1316	373	424			380		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	94	100	64	87	95	98	77			99		
cM capacity (veh/h)	104	122	633	50	123	677	1125			1190		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	234	25	633	430
Volume Left	6	6	253	6
Volume Right	228	13	13	6
cSH	556	129	1125	1190
Volume to Capacity	0.42	0.20	0.23	0.01
Queue Length 95th (ft)	52	17	22	0
Control Delay (s)	16.1	39.7	5.2	0.2
Lane LOS	C	E	A	A
Approach Delay (s)	16.1	39.7	5.2	0.2
Approach LOS	C	E		

Intersection Summary			
Average Delay	6.2		
Intersection Capacity Utilization	66.6%	ICU Level of Service	C
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

33: 207th & COOP Rd — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	150	140	60	30	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	14	203	189	81	41	14
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	270				459	230
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	270				459	230
tC, single (s)	4.1				6.4	6.5
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.6
p0 queue free %	99				93	98
cM capacity (veh/h)	1305				554	745

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	216	270	54
Volume Left	14	0	41
Volume Right	0	81	14
cSH	1305	1700	592
Volume to Capacity	0.01	0.16	0.09
Queue Length 95th (ft)	1	0	8
Control Delay (s)	0.6	0.0	11.7
Lane LOS	A		B
Approach Delay (s)	0.6	0.0	11.7
Approach LOS			B

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	26.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

34: 207th & Edgerton Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	10	0	10	10	130	5	10	5	140	5	10
Peak Hour Factor	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Hourly flow rate (vph)	15	15	0	15	15	197	8	15	8	212	8	15

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	30	227	30	235
Volume Left (vph)	15	15	8	212
Volume Right (vph)	0	197	8	15
Hadj (s)	0.10	-0.30	0.07	0.19
Departure Headway (s)	4.9	4.3	4.9	4.7
Degree Utilization, x	0.04	0.27	0.04	0.31
Capacity (veh/h)	671	787	686	722
Control Delay (s)	8.1	8.9	8.1	9.8
Approach Delay (s)	8.1	8.9	8.1	9.8
Approach LOS	A	A	A	A

Intersection Summary			
Delay	9.2		
HCM Level of Service	A		
Intersection Capacity Utilization	31.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

35: 207th & Evening Star Rd — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	20	5	5	20	5	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	40	10	10	40	10	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			50		105	45
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			50		105	45
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		99	99
cM capacity (veh/h)			1570		892	1031

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	50	50	20
Volume Left	0	10	10
Volume Right	10	0	10
cSH	1700	1570	956
Volume to Capacity	0.03	0.01	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	1.5	8.8
Lane LOS		A	A
Approach Delay (s)	0.0	1.5	8.8
Approach LOS			A

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	15.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

36: 215th & Evening Star Rd — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	5	5	0	5	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	10	10	0	10	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	10				20	10
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	10				20	10
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	99
cM capacity (veh/h)	1623				1002	1077

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	10	10	20
Volume Left	0	0	10
Volume Right	0	0	10
cSH	1623	1700	1038
Volume to Capacity	0.00	0.01	0.02
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	0.0	8.5
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.5
Approach LOS			A

Intersection Summary			
Average Delay	4.3		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Gardner IMF Operations + Induced Development - (Improved + Mitigated) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

37: 199th Street & West Waverley

PM Peak Hour

Movement	EBL	EBT	WBU	WBT	WBR	SWL	SWR
Lane Configurations							
Volume (vph)	5	820	0	830	140	200	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0		5.0	
Lane Util. Factor	1.00	1.00		1.00		1.00	
Frt	1.00	1.00		0.98		1.00	
Flt Protected	0.95	1.00		1.00		0.95	
Satd. Flow (prot)	1805	1652		1511		1463	
Flt Permitted	0.17	1.00		1.00		0.95	
Satd. Flow (perm)	322	1652		1511		1463	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	5	891	0	902	152	217	5
RTOR Reduction (vph)	0	0	0	5	0	1	0
Lane Group Flow (vph)	5	891	0	1049	0	221	0
Heavy Vehicles (%)	0%	15%	2%	17%	59%	24%	0%
Turn Type	Perm		Perm				
Protected Phases		4		8		6	
Permitted Phases	4		8				
Actuated Green, G (s)	90.4	90.4		90.4		19.6	
Effective Green, g (s)	90.4	90.4		90.4		19.6	
Actuated g/C Ratio	0.75	0.75		0.75		0.16	
Clearance Time (s)	5.0	5.0		5.0		5.0	
Vehicle Extension (s)	3.0	3.0		3.0		3.0	
Lane Grp Cap (vph)	243	1245		1138		239	
v/s Ratio Prot		0.54		c0.69		c0.15	
v/s Ratio Perm	0.02						
v/c Ratio	0.02	0.72		0.92		0.93	
Uniform Delay, d1	3.7	7.9		11.9		49.5	
Progression Factor	1.00	1.00		1.11		1.00	
Incremental Delay, d2	0.2	3.5		8.4		38.1	
Delay (s)	3.9	11.5		21.6		87.6	
Level of Service	A	B		C		F	
Approach Delay (s)		11.4		21.6		87.6	
Approach LOS		B		C		F	

Intersection Summary			
HCM Average Control Delay	24.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	71.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

38: 199th Street & IH-35 SB Ramp

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	770	240	120	170	0	0	0	0	10	0	800
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		1.00		1.00	1.00					1.00		1.00
Frt		0.97		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		1572		1752	1727					1805		1282
Flt Permitted		1.00		0.11	1.00					0.95		1.00
Satd. Flow (perm)		1572		210	1727					1805		1282
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	837	261	130	185	0	0	0	0	11	0	870
RTOR Reduction (vph)	0	9	0	0	0	0	0	0	0	0	0	656
Lane Group Flow (vph)	0	1089	0	130	185	0	0	0	0	11	0	214
Heavy Vehicles (%)	0%	21%	4%	3%	10%	0%	0%	0%	0%	0%	0%	26%
Turn Type				pm+pt						Prot		custom
Protected Phases		4		3	8					6		
Permitted Phases				8								3 6
Actuated Green, G (s)		86.0		99.0	99.0					11.0		24.0
Effective Green, g (s)		86.0		99.0	99.0					11.0		24.0
Actuated g/C Ratio		0.72		0.82	0.82					0.09		0.20
Clearance Time (s)		5.0		5.0	5.0					5.0		
Vehicle Extension (s)		3.0		3.0	3.0					3.0		
Lane Grp Cap (vph)		1127		276	1425					165		256
v/s Ratio Prot		c0.69		0.03	0.11					0.01		
v/s Ratio Perm				0.36								c0.17
v/c Ratio		0.97		0.47	0.13					0.07		0.84
Uniform Delay, d1		15.7		17.8	2.1					49.8		46.1
Progression Factor		1.02		1.00	1.00					1.00		1.00
Incremental Delay, d2		14.7		1.3	0.0					0.2		20.4
Delay (s)		30.7		19.1	2.1					50.0		66.5
Level of Service		C		B	A					D		E
Approach Delay (s)		30.7			9.1			0.0			66.3	
Approach LOS		C			A			A			E	

Intersection Summary			
HCM Average Control Delay	41.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	77.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

39: 199th Street & IH-35 NB Ramp

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	670	110	0	0	210	20	80	0	50	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0		5.0			
Lane Util. Factor	1.00	1.00			1.00		1.00		1.00			
Frt	1.00	1.00			0.99		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1456	1810			1796		1597		1583			
Flt Permitted	0.47	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	725	1810			1796		1597		1583			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	728	120	0	0	228	22	87	0	54	0	0	0
RTOR Reduction (vph)	0	0	0	0	4	0	0	0	49	0	0	0
Lane Group Flow (vph)	728	120	0	0	246	0	87	0	5	0	0	0
Heavy Vehicles (%)	24%	5%	0%	0%	5%	0%	13%	0%	2%	0%	0%	0%
Turn Type	pm+pt						custom		custom			
Protected Phases	7	4			8							
Permitted Phases	4						2		2			
Actuated Green, G (s)	71.0	71.0			22.3		9.0		9.0			
Effective Green, g (s)	71.0	71.0			22.3		9.0		9.0			
Actuated g/C Ratio	0.79	0.79			0.25		0.10		0.10			
Clearance Time (s)	5.0	5.0			5.0		5.0		5.0			
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Lane Grp Cap (vph)	927	1428			445		160		158			
v/s Ratio Prot	c0.38	0.07			0.14							
v/s Ratio Perm	c0.24						c0.05		0.00			
v/c Ratio	0.79	0.08			0.55		0.54		0.03			
Uniform Delay, d1	8.6	2.1			29.5		38.5		36.6			
Progression Factor	1.00	1.00			1.21		1.00		1.00			
Incremental Delay, d2	4.4	0.1			1.4		3.7		0.1			
Delay (s)	13.0	2.3			37.2		42.3		36.7			
Level of Service	B	A			D		D		D			
Approach Delay (s)		11.5			37.2			40.1			0.0	
Approach LOS		B			D			D			A	

Intersection Summary			
HCM Average Control Delay	19.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	77.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

40: 199th Street & East Waverley

PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	160	10	5	220	10	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	174	11	5	239	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	820					
pX, platoon unblocked						
vC, conflicting volume			185		429	179
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			185		429	179
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	99
cM capacity (veh/h)			1402		584	869

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	185	245	16
Volume Left	0	5	11
Volume Right	11	0	5
cSH	1700	1402	656
Volume to Capacity	0.11	0.00	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.2	10.6
Lane LOS		A	B
Approach Delay (s)	0.0	0.2	10.6
Approach LOS			B

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	25.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

80: 191st Street & Driveway A

PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	130	20	30	80	50	120
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	141	22	33	87	54	130
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	120				380	76
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	120				380	76
tC, single (s)	5.1				7.4	7.2
tC, 2 stage (s)						
tF (s)	3.1				4.4	4.2
p0 queue free %	86				87	83
cM capacity (veh/h)	1032				404	769

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	163	120	54	130
Volume Left	141	0	54	0
Volume Right	0	87	0	130
cSH	1032	1700	404	769
Volume to Capacity	0.14	0.07	0.13	0.17
Queue Length 95th (ft)	12	0	12	15
Control Delay (s)	8.0	0.0	15.3	10.6
Lane LOS	A		C	B
Approach Delay (s)	8.0	0.0	12.0	
Approach LOS			B	

Intersection Summary			
Average Delay	7.5		
Intersection Capacity Utilization	24.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

81: 191st Street & Driveway B

PM Peak Hour

Intersection Sign configuration not allowed in HCM analysis.

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

82: Driveway C & Waverly Road

PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	10	10	5	190	230	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	11	5	207	250	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	470	253	255			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	470	253	255			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	99	100			
cM capacity (veh/h)	553	791	1321			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	11	11	212	255
Volume Left	11	0	5	0
Volume Right	0	11	0	5
cSH	553	791	1321	1700
Volume to Capacity	0.02	0.01	0.00	0.15
Queue Length 95th (ft)	2	1	0	0
Control Delay (s)	11.6	9.6	0.2	0.0
Lane LOS	B	A	A	
Approach Delay (s)	10.6		0.2	0.0
Approach LOS	B			

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	24.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)

83: Driveway D & Waverly Road

PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	100	80	50	410	340	90
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	109	87	54	446	370	98
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	750	234	467			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	750	234	467			
tC, single (s)	6.9	6.9	4.1			
tC, 2 stage (s)						
tF (s)	3.6	3.3	2.2			
p0 queue free %	66	89	95			
cM capacity (veh/h)	324	774	1090			

Direction, Lane #	EB 1	EB 2	NB 1	NB 2	SB 1	SB 2
Volume Total	109	87	203	297	246	221
Volume Left	109	0	54	0	0	0
Volume Right	0	87	0	0	0	98
cSH	324	774	1090	1700	1700	1700
Volume to Capacity	0.34	0.11	0.05	0.17	0.14	0.13
Queue Length 95th (ft)	36	9	4	0	0	0
Control Delay (s)	21.6	10.2	2.6	0.0	0.0	0.0
Lane LOS	C	B	A			
Approach Delay (s)	16.6		1.1		0.0	
Approach LOS	C					

Intersection Summary			
Average Delay	3.2		
Intersection Capacity Utilization	40.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Gardner Proposed Action + Indirect Effects - (Imp+Mit)
84: 191st Street & Driveway E — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	60	110	5	5	0
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	65	120	5	5	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	125				188	122
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	125				188	122
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	100
cM capacity (veh/h)	1474				806	934

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	65	125	5
Volume Left	0	0	5
Volume Right	0	5	0
cSH	1474	1700	806
Volume to Capacity	0.00	0.07	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	0.0	9.5
Lane LOS			A
Approach Delay (s)	0.0	0.0	9.5
Approach LOS			A

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	16.1%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Gardner IMF Operations + Induced Development - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

__________Operational Analysis__________

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 1:13:38 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Edgerton Road to Sunflower Road
Jurisdiction:	
Analysis Year:	2010
Description:	NEPA Traffic Study

__________Flow Inputs and Adjustments__________

Volume, V	1195	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	332	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	694	pc/h/ln

__________Speed Inputs and Adjustments__________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

__________LOS and Performance Measures__________

Flow rate, vp	694	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	9.9	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

__________Operational Analysis__________

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 1:13:38 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Sunflower Road to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

__________Flow Inputs and Adjustments__________

Volume, V	1460	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	406	v
Trucks and buses	8	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.962	
Driver population factor, fp	1.00	
Flow rate, vp	844	pc/h/ln

__________Speed Inputs and Adjustments__________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

__________LOS and Performance Measures__________

Flow rate, vp	844	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	12.1	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Gardner IMF Operations + Induced Development - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 1:13:38 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Gardner Road to US 56
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	2070	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	575	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1208	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	1208	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	17.3	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 1:13:38 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	US 56 to 151st Street
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	3380	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	939	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1934	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	1934	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	66.0	mi/h
Number of lanes, N	2	
Density, D	29.3	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Gardner IMF Operations + Induced Development - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_____Operational Analysis_____

```
Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         4/2/2008 1:13:38 PM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Southbound
From/To:                151Street to US 56
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study
```

_____Flow Inputs and Adjustments_____

```
Volume, V                               1620         veh/h
Peak-hour factor, PHF                   0.90
Peak 15-min volume, v15                 450          v
Trucks and buses                        11           %
Recreational vehicles                   0            %
Terrain type:                           Level
    Grade                               0.00         %
    Segment length                      0.00         mi
Trucks and buses PCE, ET                1.5
Recreational vehicle PCE, ER            1.2
Heavy vehicle adjustment, fHV           0.948
Driver population factor, fp            1.00
Flow rate, vp                           950          pc/h/ln
```

_____Speed Inputs and Adjustments_____

```
Lane width                              12.0         ft
Right-shoulder lateral clearance        6.0          ft
Interchange density                     0.50         interchange/mi
Number of lanes, N                      2
Free-flow speed:                        Measured
     FFS or BFFS                        70.0         mi/h
Lane width adjustment, fLW              0.0          mi/h
Lateral clearance adjustment, fLC       0.0          mi/h
Interchange density adjustment, fID     0.0          mi/h
Number of lanes adjustment, fN          0.0          mi/h
Free-flow speed, FFS                    70.0         mi/h
                                        Rural Freeway
```

_____LOS and Performance Measures_____

```
Flow rate, vp                           950          pc/h/ln
Free-flow speed, FFS                    70.0         mi/h
Average passenger-car speed, S          70.0         mi/h
Number of lanes, N                      2
Density, D                              13.6         pc/mi/ln
Level of service, LOS                   B
```

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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_____Operational Analysis_____

```
Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         4/2/2008 1:13:38 PM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Southbound
From/To:                US 56 to Gardner Road
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study
```

_____Flow Inputs and Adjustments_____

```
Volume, V                               720          veh/h
Peak-hour factor, PHF                   0.90
Peak 15-min volume, v15                 200          v
Trucks and buses                        22           %
Recreational vehicles                   0            %
Terrain type:                           Level
    Grade                               0.00         %
    Segment length                      0.00         mi
Trucks and buses PCE, ET                1.5
Recreational vehicle PCE, ER            1.2
Heavy vehicle adjustment, fHV           0.901
Driver population factor, fp            1.00
Flow rate, vp                           444          pc/h/ln
```

_____Speed Inputs and Adjustments_____

```
Lane width                              12.0         ft
Right-shoulder lateral clearance        6.0          ft
Interchange density                     0.50         interchange/mi
Number of lanes, N                      2
Free-flow speed:                        Measured
     FFS or BFFS                        70.0         mi/h
Lane width adjustment, fLW              0.0          mi/h
Lateral clearance adjustment, fLC       0.0          mi/h
Interchange density adjustment, fID     0.0          mi/h
Number of lanes adjustment, fN          0.0          mi/h
Free-flow speed, FFS                    70.0         mi/h
                                        Rural Freeway
```

_____LOS and Performance Measures_____

```
Flow rate, vp                           444          pc/h/ln
Free-flow speed, FFS                    70.0         mi/h
Average passenger-car speed, S          70.0         mi/h
Number of lanes, N                      2
Density, D                              6.3          pc/mi/ln
Level of service, LOS                   A
```

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Gardner IMF Operations + Induced Development - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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E-mail:

_____Operational Analysis_____

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 4/2/2008 1:13:38 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Southbound
From/To: Gardner Road to Sunflower Road
Jurisdiction: KDOT
Analysis Year: 2010
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	540	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	150	v
Trucks and buses	18	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.917	
Driver population factor, fp	1.00	
Flow rate, vp	327	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	327	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	4.7	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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_____Operational Analysis_____

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 4/2/2008 1:13:38 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Southbound
From/To: Sunflower Road to Edgerton Road
Jurisdiction:
Analysis Year: 2010
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	505	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	140	v
Trucks and buses	19	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.913	
Driver population factor, fp	1.00	
Flow rate, vp	307	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	307	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	4.4	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 1:13:38 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Edgerton Road to Sunflower Road
Jurisdiction:	
Analysis Year:	2010
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	705	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	196	v
Trucks and buses	20	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.909	
Driver population factor, fp	1.00	
Flow rate, vp	431	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	431	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	6.2	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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E-mail:

Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 1:13:38 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Sunflower Road to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	790	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	219	v
Trucks and buses	18	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.917	
Driver population factor, fp	1.00	
Flow rate, vp	478	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	478	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	6.8	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Gardner IMF Operations + Induced Development - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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_______________Operational Analysis_______________

```
Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         4/2/2008 1:13:38 PM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Northbound
From/To:                Gardner Road to US 56
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study
```

_______________Flow Inputs and Adjustments_______________

Volume, V	1090	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	303	v
Trucks and buses	21	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.905	
Driver population factor, fp	1.00	
Flow rate, vp	669	pc/h/ln

_______________Speed Inputs and Adjustments_______________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______________LOS and Performance Measures_______________

Flow rate, vp	669	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	9.6	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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_______________Operational Analysis_______________

```
Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         4/2/2008 1:13:38 PM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Northbound
From/To:                US 56 to 151st Street
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study
```

_______________Flow Inputs and Adjustments_______________

Volume, V	1970	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	547	v
Trucks and buses	12	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.943	
Driver population factor, fp	1.00	
Flow rate, vp	1160	pc/h/ln

_______________Speed Inputs and Adjustments_______________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______________LOS and Performance Measures_______________

Flow rate, vp	1160	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	16.6	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Gardner IMF Operations + Induced Development - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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E-mail:

_____Operational Analysis_____

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 4/2/2008 1:13:38 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: 151Street to US 56
Jurisdiction: KDOT
Analysis Year: 2010
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	3210	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	892	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1864	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	1864	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	67.1	mi/h
Number of lanes, N	2	
Density, D	27.8	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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_____Operational Analysis_____

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 4/2/2008 1:13:38 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: US 56 to Gardner Road
Jurisdiction: KDOT
Analysis Year: 2010
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	2210	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	614	v
Trucks and buses	13	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.939	
Driver population factor, fp	1.00	
Flow rate, vp	1308	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	1308	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	18.7	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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_____Operational Analysis_____

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 4/2/2008 1:13:38 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: Gardner Road to Sunflower Road
Jurisdiction: KDOT
Analysis Year: 2010
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	1640	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	456	v
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.948	
Driver population factor, fp	1.00	
Flow rate, vp	961	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	961	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	13.7	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 4/2/2008 1:13:38 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: Sunflower Road to Edgerton Road
Jurisdiction:
Analysis Year: 2010
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	1390	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	386	v
Trucks and buses	13	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.939	
Driver population factor, fp	1.00	
Flow rate, vp	822	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	822	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	11.7	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

```
                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 1:13:38 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          1195          vph

________________________________Off Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0          mph
Volume on ramp                             15            vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1195        15                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                332         4                    v
Trucks and buses                       9           7                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.957       0.905
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1388        18                         pcph

________________________Estimation of V12 Diverge Areas________________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1388   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                1388          4800            No
      Fi   F
     v  = v - v            1370          4800            No
      FO   F   R
     v                     18            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                1388          4600                  No
      12                                                                    !
________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =    9.0     pc/mi/ln
                       R                 12         D
Level of service for ramp-freeway junction areas of influence A

____________________________Speed Estimation__________________________________

Intermediate speed variable,                D  = 0.430
                                             S
Space mean speed in ramp influence area,    S  = 58.0    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 58.0    mph
______________________________________________________________________________
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Phone:                                   Fax:
E-mail:

________________________________Merge Analysis_________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 1:13:38 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          1180          vph

_________________________________On Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0          mph
Volume on ramp                             280           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1180        280                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                328         78                   v
Trucks and buses                       9           1                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.957       0.985
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1370        316                        pcph

________________________Estimation of V12 Merge Areas__________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1370   pc/h
                   12   F   FM

______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     1686          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                1370          4400                  No
      12                                                                    !
________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   13.5    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

____________________________Speed Estimation__________________________________

Intermediate speed variable,                M  = 0.286
                                             S
Space mean speed in ramp influence area,    S  = 62.0    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 62.0    mph
______________________________________________________________________________
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_________________________________Diverge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 1:13:38 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1460          vph

_________________________________Off Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            100           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1460        100                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               406         28                   v
Trucks and buses                      8           4                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %            %
     Length                           0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.962       0.943
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1687        118                    pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1687   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1687          4800            No
      Fi   F
     v  = v - v            1569          4800            No
      FO   F   R
     v                     118           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1687          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   11.6    pc/mi/ln
                      R                  12          D
Level of service for ramp-freeway junction areas of influence B

________________________________Speed Estimation_______________________________

Intermediate speed variable,                 D  = 0.439
                                              S
Space mean speed in ramp influence area,     S  = 57.7    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.7    mph
_______________________________________________________________________________
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_________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 1:13:38 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1360          vph

__________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            710           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1360        710                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               378         197                  v
Trucks and buses                      8           13                   %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                                    %           %            %
     Length                                   mi          mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.962       0.837
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1572        943                    pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1572   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2515          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1572          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   19.6    pc/mi/ln
          R                  R            12            A
Level of service for ramp-freeway junction areas of influence  B

________________________________Speed Estimation_______________________________

Intermediate speed variable,                 M  = 0.313
                                              S
Space mean speed in ramp influence area,     S  = 61.2    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.2    mph
_______________________________________________________________________________
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2010 Gardner IMF Operations + Induced Development - AM Peak Hour - HCS Freeway Ramps

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_________________________________Diverge Analysis______________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          4/2/2008 1:13:38 PM
Analysis time period:    AM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                5 US-56 Exit
Jurisdiction:            KDOT
Analysis Year:           2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           2070           vph

_________________________________Off Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              240            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2070        240                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 575         67                    v
Trucks and buses                        10          8                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %             %
     Length                             0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.952       0.893
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2415        299                      pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2415   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                2415          4800            No
      Fi   F
     v  = v - v            2116          4800            No
      FO   F   R
     v                     299           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                2415          4600                   No
      12                                                                    !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   17.8    pc/mi/ln
                                          R            12         D
Level of service for ramp-freeway junction areas of influence B

_______________________________Speed Estimation________________________________

Intermediate speed variable,                 D  = 0.455
                                              S
Space mean speed in ramp influence area,     S  = 57.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.3    mph
_______________________________________________________________________________
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_________________________________Merge Analysis________________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          4/2/2008 1:13:38 PM
Analysis time period:    AM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                6 US-56 Entr
Jurisdiction:            KDOT
Analysis Year:           2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           3250           vph

__________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              130            vph
Length of first accel/decel lane            1000           ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         3250        130                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 903         36                    v
Trucks and buses                        10          2                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                                      %           %             %
     Length                                     mi          mi            mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.952       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3792        149                      pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  3792   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     3941          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                3792          4400                   No
      12                                                                    !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   29.9    pc/mi/ln
                              R            12           A
Level of service for ramp-freeway junction areas of influence  D

_______________________________Speed Estimation________________________________

Intermediate speed variable,                 M  = 0.452
                                              S
Space mean speed in ramp influence area,     S  = 57.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.4    mph
_______________________________________________________________________________
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2010 Gardner IMF Operations + Induced Development - AM Peak Hour - HCS Freeway Ramps

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                      HCS+: Ramps and Ramp Junctions Release 5.21




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_________________________________Merge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 1:13:38 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1830          vph

__________________________________On Ramp Data______________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              1420          vph
Length of first accel/decel lane            500           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1830        1420                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 508         394                   v
Trucks and buses                        10          2                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.952       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2135        1625                  pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2135   pc/h
                   12   F   FM

______________________________Capacity Checks_________________________________

                           Actual        Maximum        LOS F?
     v                     3760          4800           No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v         > 2700 pc/h?        No
      3 or  av34
Is   v     v         > 1.5 v  /2         No
      3 or  av34            12
If yes, v    =                           (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                2135          4400                 No
      12                                                                  !
________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   30.9    pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  D

____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.453
                                              S
Space mean speed in ramp influence area,     S  = 57.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.3    mph
______________________________________________________________________________
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Phone:                                     Fax:
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_________________________________Diverge Analysis____________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 1:13:38 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               8 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1620          vph

_________________________________Off Ramp Data______________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     45.0          mph
Volume on ramp                              970           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1620        970                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 450         269                   v
Trucks and buses                        11          3                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                              0.00   %    0.00   %            %
     Length                             0.00   mi   0.00   mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
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Heavy vehicle adjustment, fHV           0.948       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1899        1126                  pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1899   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_________________________________

                           Actual        Maximum        LOS F?
     v  = v                1899          4800           No
      Fi   F
     v  = v - v            773           4800           No
      FO   F   R
     v                     1126          2100           No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v         > 2700 pc/h?        No
      3 or  av34
Is   v     v         > 1.5 v  /2         No
      3 or  av34            12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable        Violation?
     v                1899          4600                 No
      12                                                                  !
________________Level of Service Determination (if not F)____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   13.4    pc/mi/ln
                        R                  12           D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.399
                                              S
Space mean speed in ramp influence area,     S  = 58.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 58.8    mph
______________________________________________________________________________
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E-mail:

_________________________________Merge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 1:13:38 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               9 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           650            vph

__________________________________On Ramp Data_______________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              70             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         650         70                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 181         19                   v
Trucks and buses                        11          16                   %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.948       0.806
Driver population factor, fP            1.00        1.00
Flow rate, vp                           762         96                      pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  762    pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum        LOS F?
     v                     858           4800           No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                762           4400                  No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   7.1     pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  A

____________________________Speed Estimation__________________________________

Intermediate speed variable,                  M  = 0.274
                                               S
Space mean speed in ramp influence area,      S  = 62.3    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 62.3    mph
_______________________________________________________________________________
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Phone:                                      Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 1:13:38 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           720            vph

________________________________Off Ramp Data________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              240            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         720         240                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 200         67                   v
Trucks and buses                        22          0                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.901       1.000
Driver population factor, fP            1.00        1.00
Flow rate, vp                           888         267                     pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  888    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                           Actual        Maximum        LOS F?
     v  = v                888           4800           No
      Fi   F
     v  = v - v            621           4800           No
      FO   F   R
     v                     267           2000           No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                888           4600                  No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   4.7     pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence A

____________________________Speed Estimation__________________________________

Intermediate speed variable,                  D  = 0.452
                                               S
Space mean speed in ramp influence area,      S  = 57.3    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 57.3    mph
_______________________________________________________________________________
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2010 Gardner IMF Operations + Induced Development - AM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 1:13:38 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         480           vph

__________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            60            vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        480         60                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                133         17                   v
Trucks and buses                       22          8                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.901       0.893
Driver population factor, fP           1.00        1.00
Flow rate, vp                          592         75                        pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =           (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  592    pc/h
                   12   F   FM

______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     667           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                592           4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   5.6     pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  A

____________________________Speed Estimation___________________________________

Intermediate speed variable,              M  = 0.273
                                           S
Space mean speed in ramp influence area,  S  = 62.4    mph
                                           R
Space mean speed in outer lanes,          S  =  N/A    mph
                                           0
Space mean speed for all vehicles,        S  = 62.4    mph
_______________________________________________________________________________
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________________________________Diverge Analysis_______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 1:13:38 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         540           vph

_________________________________Off Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            50            vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        540         50                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                150         14                   v
Trucks and buses                       18          4                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00   %    0.00   %           %
     Length                            0.00   mi   0.00   mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.917       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          654         59                        pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =           (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  654    pc/h
                   12   R     F   R   FD

______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                654           4800            No
      Fi   F
     v  = v - v            595           4800            No
      FO   F   R
     v                     59            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                654           4600                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   2.7     pc/mi/ln
                       R                 12           D
Level of service for ramp-freeway junction areas of influence A

____________________________Speed Estimation___________________________________

Intermediate speed variable,              D  = 0.433
                                           S
Space mean speed in ramp influence area,  S  = 57.9    mph
                                           R
Space mean speed in outer lanes,          S  =  N/A    mph
                                           0
Space mean speed for all vehicles,        S  = 57.9    mph
_______________________________________________________________________________
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_________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 1:13:38 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           505           vph

__________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              15            vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         505         15                    vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 140         4                     v
Trucks and buses                        18          0                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                                      %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.917       1.000
Driver population factor, fP            1.00        1.00
Flow rate, vp                           612         17                    pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  612    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     629           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                612           4400                  No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   5.4     pc/mi/ln
                              R            12            A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.272
                                              S
Space mean speed in ramp influence area,     S  = 62.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.4    mph
_______________________________________________________________________________
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E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          4/2/2008 1:13:38 PM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                1 Sunflower Exit
Jurisdiction:            KDOT
Analysis Year:           2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           705            vph

________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              15             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        705         15                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                196         4                    v
Trucks and buses                       20          0                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.909       1.000
Driver population factor, fP           1.00        1.00
Flow rate, vp                          862         17                        pcph

_________________________Estimation of V12 Diverge Areas______________________

                 L  =            (Equation 25-8 or 25-9)
                  EQ
                 P  =    1.000   Using Equation  0
                  FD
                 v  = v  + (v - v ) P  =  862    pc/h
                  12   R     F   R   FD

______________________________Capacity Checks_________________________________

                             Actual        Maximum         LOS F?
     v  = v                  862           4800            No
      Fi   F
     v  = v - v              845           4800            No
      FO   F   R
     v                       17            2000            No
      R
     v     v                 0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?             No
      3 or  av34
Is   v     v      > 1.5 v  /2              No
      3 or  av34         12
If yes, v    =                             (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                        Actual        Max Desirable          Violation?
     v                  862           4600                   No
      12                                                                       !
_________________Level of Service Determination (if not F)____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   4.5     pc/mi/ln
                      R                  12         D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                 D  = 0.430
                                              S
Space mean speed in ramp influence area,     S  = 58.0    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 58.0    mph
______________________________________________________________________________
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E-mail:

________________________________Merge Analysis_________________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          4/2/2008 1:13:38 PM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                2 Sunflower Entr
Jurisdiction:            KDOT
Analysis Year:           2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           690            vph

_________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              100            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        690         100                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                192         28                   v
Trucks and buses                       20          4                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.909       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          843         118                       pcph

_________________________Estimation of V12 Merge Areas________________________

                 L  =            (Equation 25-2 or 25-3)
                  EQ
                 P  =    1.000   Using Equation  0
                  FM
                 v  = v  (P  ) =  843    pc/h
                  12   F   FM

______________________________Capacity Checks_________________________________

                             Actual        Maximum         LOS F?
     v                       961           4800            No
      FO
     v     v                 0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?             No
      3 or  av34
Is   v     v      > 1.5 v  /2              No
      3 or  av34         12
If yes, v    =                             (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area____________________
                        Actual        Max Desirable          Violation?
     v                  843           4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   7.9     pc/mi/ln
           R                  R         12              A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                 M  = 0.275
                                              S
Space mean speed in ramp influence area,     S  = 62.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.3    mph
______________________________________________________________________________
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Phone:                                   Fax:
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________________________________Diverge Analysis_______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 1:13:38 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         790            vph

________________________________Off Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0           mph
Volume on ramp                            70             vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        790         70                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                219         19                   v
Trucks and buses                       18          10                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
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Heavy vehicle adjustment, fHV          0.917       0.870
Driver population factor, fP           1.00        1.00
Flow rate, vp                          957         89                   pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  957    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                957           4800            No
      Fi   F
     v  = v - v            868           4800            No
      FO   F   R
     v                     89            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                957           4600                  No
      12                                                                     !
________________Level of Service Determination (if not F)_____________________

Density,           D = 4.252 + 0.0086 v  - 0.009  L   =    5.3     pc/mi/ln
                    R                  12          D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.436
                                              S
Space mean speed in ramp influence area,     S  = 57.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.8    mph
_______________________________________________________________________________
```

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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

________________________________Merge Analysis_________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 1:13:38 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         720            vph

_________________________________On Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0           mph
Volume on ramp                            370            vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        720         370                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                200         103                  v
Trucks and buses                       18          24                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
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Heavy vehicle adjustment, fHV          0.917       0.735
Driver population factor, fP           1.00        1.00
Flow rate, vp                          872         559                  pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  872    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1431          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                872           4400                  No
      12                                                                     !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =    11.4    pc/mi/ln
          R                   R            12           A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.281
                                              S
Space mean speed in ramp influence area,     S  = 62.1    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.1    mph
_______________________________________________________________________________
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2010 Gardner IMF Operations + Induced Development - PM Peak Hour - HCS Freeway Ramps

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                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                     Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          4/2/2008 1:13:38 PM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                5 US-56 Exit
Jurisdiction:            KDOT
Analysis Year:           2010
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1090           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              120            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1090        120                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 303         33                    v
Trucks and buses                        21          10                    %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %             %
     Length                             0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.905       0.870
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1338        153                   pcph

_________________________Estimation of V12 Diverge Areas_________________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1338   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                            Actual        Maximum         LOS F?
     v  = v                 1338          4800            No
      Fi   F
     v  = v - v             1185          4800            No
      FO   F   R
     v                      153           2000            No
      R
     v     v                0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?           No
      3 or  av34
Is   v     v       > 1.5 v  /2            No
      3 or  av34          12
If yes, v    =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                       Actual        Max Desirable          Violation?
     v                 1338          4600                   No
      12                                                                     !
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   8.6     pc/mi/ln
                          R                12          D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.442
                                              S
Space mean speed in ramp influence area,     S  = 57.6    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.6    mph
________________________________________________________________________________
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_________________________________Merge Analysis__________________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          4/2/2008 1:13:38 PM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                6 US-56 Entr
Jurisdiction:            KDOT
Analysis Year:           2010
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1950           vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              20             vph
Length of first accel/decel lane            1000           ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1950        20                    vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 542         6                     v
Trucks and buses                        21          3                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                                      %           %             %
     Length                                     mi          mi            mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.905       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2394        23                    pcph

__________________________Estimation of V12 Merge Areas__________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2394   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                            Actual        Maximum         LOS F?
     v                      2417          4800            No
      FO
     v     v                0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?           No
      3 or  av34
Is   v     v       > 1.5 v  /2            No
      3 or  av34          12
If yes, v    =                            (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area______________________
                       Actual        Max Desirable          Violation?
     v                 2394          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   18.0    pc/mi/ln
              R             R         12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.295
                                              S
Space mean speed in ramp influence area,     S  = 61.7    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.7    mph
________________________________________________________________________________
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_________________________________Merge Analysis________________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          4/2/2008 1:13:38 PM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                7 Loop Ramp Entr
Jurisdiction:            KDOT
Analysis Year:           2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          970           vph

__________________________________On Ramp Data_________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0          mph
Volume on ramp                             980           vph
Length of first accel/decel lane           500           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        970         980                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                269         272                  v
Trucks and buses                       21          3                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.905       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1191        1138                   pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1191   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2329          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable         Violation?
     v                1191          4400                  No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   20.0-   pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.326
                                              S
Space mean speed in ramp influence area,     S  = 60.9    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 60.9    mph
_______________________________________________________________________________
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Phone:                                     Fax:
E-mail:

_________________________________Diverge Analysis______________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          4/2/2008 1:13:38 PM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Southbound
Junction:                8 US 56 Exit
Jurisdiction:            KDOT
Analysis Year:           2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          3210          vph

_________________________________Off Ramp Data_________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    45.0          mph
Volume on ramp                             1320          vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        3210        1320                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                892         367                  v
Trucks and buses                       9           2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.957       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3727        1511                   pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  3727   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                3727          4800            No
      Fi   F
     v  = v - v            2216          4800            No
      FO   F   R
     v                     1511          2100            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                3727          4600                  No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,                D = 4.252 + 0.0086 v  - 0.009  L   =   29.1    pc/mi/ln
                      R                  12          D
Level of service for ramp-freeway junction areas of influence D

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.434
                                              S
Space mean speed in ramp influence area,     S  = 57.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.8    mph
_______________________________________________________________________________
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2010 Gardner IMF Operations + Induced Development - PM Peak Hour - HCS Freeway Ramps

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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          4/2/2008 1:13:38 PM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Southbound
Junction:                9 US 56 Entr
Jurisdiction:            KDOT
Analysis Year:           2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1890          vph

_________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            320           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1890        320                 vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               525         89                  v
Trucks and buses                      9           4                   %
Recreational vehicles                 0           0                   %
Terrain type:                         Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.957       0.943
Driver population factor, fP          1.00        1.00
Flow rate, vp                         2195        377                 pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2195   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v                     2572          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                2195          4400                  No
      12                                                                     !
________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   20.3    pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  C

____________________________Speed Estimation__________________________________

Intermediate speed variable,                M  = 0.316
                                             S
Space mean speed in ramp influence area,    S  = 61.2    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 61.2    mph
______________________________________________________________________________
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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
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________________________________Diverge Analysis______________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          4/2/2008 1:13:38 PM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Southbound
Junction:                10 Gardner Exit
Jurisdiction:            KDOT
Analysis Year:           2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         2210          vph

________________________________Off Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            670           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       2210        670                 vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               614         186                 v
Trucks and buses                      13          17                  %
Recreational vehicles                 0           0                   %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %           %
     Length                           0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.939       0.797
Driver population factor, fP          1.00        1.00
Flow rate, vp                         2615        934                 pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2615   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v  = v                2615          4800            No
      Fi   F
     v  = v - v            1681          4800            No
      FO   F   R
     v                     934           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable         Violation?
     v                2615          4600                  No
      12                                                                     !
________________Level of Service Determination (if not F)____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   19.5    pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation__________________________________

Intermediate speed variable,                D  = 0.512
                                             S
Space mean speed in ramp influence area,    S  = 55.7    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 55.7    mph
______________________________________________________________________________
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2010 Gardner IMF Operations + Induced Development - PM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 1:13:38 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1540          vph

__________________________________On Ramp Data_______________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              100           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1540        100                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 428         28                   v
Trucks and buses                        13          8                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.939       0.893
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1822        124                    pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1822   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v                     1946          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1822          4400                   No
      12                                                                     !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   15.6    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                M  = 0.292
                                             S
Space mean speed in ramp influence area,    S  = 61.8    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 61.8    mph
______________________________________________________________________________
```

```
                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis____________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 1:13:38 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1640          vph

_________________________________Off Ramp Data_______________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              280           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1640        280                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 456         78                   v
Trucks and buses                        11          1                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.948       0.985
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1922        316                    pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1922   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v  = v                1922          4800            No
      Fi   F
     v  = v - v            1606          4800            No
      FO   F   R
     v                     316           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1922          4600                   No
      12                                                                     !
________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   13.6    pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                D  = 0.456
                                             S
Space mean speed in ramp influence area,    S  = 57.2    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.2    mph
______________________________________________________________________________
```

```
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Phone:                                      Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 1:13:38 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1360           vph

__________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              30             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1360        30                    vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                378         8                     v
Trucks and buses                       11          7                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                                     %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.948       0.905
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1594        37                    pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1594   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                             Actual        Maximum         LOS F?
     v                       1631          4800            No
      FO
     v     v                 0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?           No
      3 or  av34
Is   v     v        > 1.5 v  /2            No
      3 or  av34             12
If yes, v    =                             (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1594          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   13.2    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.285
                                              S
Space mean speed in ramp influence area,     S  = 62.0    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.0    mph
_______________________________________________________________________________
```

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Phone: Fax:
E-mail:

_______Operational Analysis_______

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/3/2008 1:55:41 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: Edgerton Road to Sunflower Road
Jurisdiction:
Analysis Year: 2015
Description: NEPA Traffic Study

_______Flow Inputs and Adjustments_______

Volume, V	1325	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	368	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	773	pc/h/ln

_______Speed Inputs and Adjustments_______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______LOS and Performance Measures_______

Flow rate, vp	773	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	11.0+	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

_______Operational Analysis_______

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/3/2008 1:55:41 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: Sunflower Road to Gardner Road
Jurisdiction: KDOT
Analysis Year: 2015
Description: NEPA Traffic Study

_______Flow Inputs and Adjustments_______

Volume, V	1730	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	481	v
Trucks and buses	8	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.962	
Driver population factor, fp	1.00	
Flow rate, vp	1000	pc/h/ln

_______Speed Inputs and Adjustments_______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______LOS and Performance Measures_______

Flow rate, vp	1000	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	14.3	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

Level of service, LOS	C

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/3/2008 1:55:41 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Gardner Road to US 56
Jurisdiction:	KDOT
Analysis Year:	2015

Description: NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	2410	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	669	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1406	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	1406	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	20.1	pc/mi/ln

Level of service, LOS	E

Overall results are not computed when free-flow speed is less than 55 mph.

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E-mail:

Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/3/2008 1:55:41 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	US 56 to 151st Street
Jurisdiction:	KDOT
Analysis Year:	2015

Description: NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	3920	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1089	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2243	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	2243	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	58.8	mi/h
Number of lanes, N	2	
Density, D	38.1	pc/mi/ln

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_______________________Operational Analysis_________________________________

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/3/2008 1:55:41 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Southbound
From/To: 151Street to US 56
Jurisdiction: KDOT
Analysis Year: 2015
Description: NEPA Traffic Study

_______________________Flow Inputs and Adjustments___________________________

Volume, V	2010	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	558	v
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.948	
Driver population factor, fp	1.00	
Flow rate, vp	1178	pc/h/ln

_______________________Speed Inputs and Adjustments__________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______________________LOS and Performance Measures__________________________

Flow rate, vp	1178	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	16.8	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

_______________________Operational Analysis_________________________________

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/3/2008 1:55:41 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Southbound
From/To: US 56 to Gardner Road
Jurisdiction: KDOT
Analysis Year: 2015
Description: NEPA Traffic Study

_______________________Flow Inputs and Adjustments___________________________

Volume, V	890	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	247	v
Trucks and buses	21	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.905	
Driver population factor, fp	1.00	
Flow rate, vp	546	pc/h/ln

_______________________Speed Inputs and Adjustments__________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______________________LOS and Performance Measures__________________________

Flow rate, vp	546	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	7.8	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

_______Operational Analysis_______

```
Analyst:                 Tom Hiles
Agency or Company:       HDR Inc.
Date Performed:          4/3/2008 1:55:41 PM
Analysis Time Period:    AM
Freeway/Direction:       I-35 Southbound
From/To:                 Gardner Road to Sunflower Road
Jurisdiction:            KDOT
Analysis Year:           2015
Description:  NEPA Traffic Study
```

_______Flow Inputs and Adjustments_______

```
Volume, V                                 630           veh/h
Peak-hour factor, PHF                     0.90
Peak 15-min volume, v15                   175           v
Trucks and buses                          19            %
Recreational vehicles                     0             %
Terrain type:                             Level
    Grade                                 0.00          %
    Segment length                        0.00          mi
Trucks and buses PCE, ET                  1.5
Recreational vehicle PCE, ER              1.2
Heavy vehicle adjustment, fHV             0.913
Driver population factor, fp              1.00
Flow rate, vp                             383           pc/h/ln
```

_______Speed Inputs and Adjustments_______

```
Lane width                                12.0          ft
Right-shoulder lateral clearance          6.0           ft
Interchange density                       0.50          interchange/mi
Number of lanes, N                        2
Free-flow speed:                          Measured
     FFS or BFFS                          70.0          mi/h
Lane width adjustment, fLW                0.0           mi/h
Lateral clearance adjustment, fLC         0.0           mi/h
Interchange density adjustment, fID       0.0           mi/h
Number of lanes adjustment, fN            0.0           mi/h
Free-flow speed, FFS                      70.0          mi/h
                                          Rural Freeway
```

_______LOS and Performance Measures_______

```
Flow rate, vp                             383           pc/h/ln
Free-flow speed, FFS                      70.0          mi/h
Average passenger-car speed, S            70.0          mi/h
Number of lanes, N                        2
Density, D                                5.5           pc/mi/ln
Level of service, LOS                                   A
```

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

_______Operational Analysis_______

```
Analyst:                 Tom Hiles
Agency or Company:       HDR Inc.
Date Performed:          4/3/2008 1:55:41 PM
Analysis Time Period:    AM
Freeway/Direction:       I-35 Southbound
From/To:                 Sunflower Road to Edgerton Road
Jurisdiction:
Analysis Year:           2015
Description:  NEPA Traffic Study
```

_______Flow Inputs and Adjustments_______

```
Volume, V                                 565           veh/h
Peak-hour factor, PHF                     0.90
Peak 15-min volume, v15                   157           v
Trucks and buses                          20            %
Recreational vehicles                     0             %
Terrain type:                             Level
    Grade                                 0.00          %
    Segment length                        0.00          mi
Trucks and buses PCE, ET                  1.5
Recreational vehicle PCE, ER              1.2
Heavy vehicle adjustment, fHV             0.909
Driver population factor, fp              1.00
Flow rate, vp                             345           pc/h/ln
```

_______Speed Inputs and Adjustments_______

```
Lane width                                12.0          ft
Right-shoulder lateral clearance          6.0           ft
Interchange density                       0.50          interchange/mi
Number of lanes, N                        2
Free-flow speed:                          Measured
     FFS or BFFS                          70.0          mi/h
Lane width adjustment, fLW                0.0           mi/h
Lateral clearance adjustment, fLC         0.0           mi/h
Interchange density adjustment, fID       0.0           mi/h
Number of lanes adjustment, fN            0.0           mi/h
Free-flow speed, FFS                      70.0          mi/h
                                          Rural Freeway
```

_______LOS and Performance Measures_______

```
Flow rate, vp                             345           pc/h/ln
Free-flow speed, FFS                      70.0          mi/h
Average passenger-car speed, S            70.0          mi/h
Number of lanes, N                        2
Density, D                                4.9           pc/mi/ln
Level of service, LOS                                   A
```

Overall results are not computed when free-flow speed is less than 55 mph.

2015 Gardner IMF Operations + Induced Development - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_______________Operational Analysis_______________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/3/2008 1:55:41 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Edgerton Road to Sunflower Road
Jurisdiction:	
Analysis Year:	2015
Description:	NEPA Traffic Study

_______________Flow Inputs and Adjustments_______________

Volume, V	795	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	221	v
Trucks and buses	21	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.905	
Driver population factor, fp	1.00	
Flow rate, vp	488	pc/h/ln

_______________Speed Inputs and Adjustments_______________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______________LOS and Performance Measures_______________

Flow rate, vp	488	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	7.0	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_______________Operational Analysis_______________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/3/2008 1:55:41 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Sunflower Road to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2015
Description:	NEPA Traffic Study

_______________Flow Inputs and Adjustments_______________

Volume, V	930	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	258	v
Trucks and buses	19	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.913	
Driver population factor, fp	1.00	
Flow rate, vp	566	pc/h/ln

_______________Speed Inputs and Adjustments_______________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______________LOS and Performance Measures_______________

Flow rate, vp	566	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	8.1	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

2015 Gardner IMF Operations + Induced Development - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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E-mail:

_____Operational Analysis_____

```
Analyst:                 Tom Hiles
Agency or Company:       HDR Inc.
Date Performed:          4/3/2008 1:55:41 PM
Analysis Time Period:    PM
Freeway/Direction:       I-35 Northbound
From/To:                 Gardner Road to US 56
Jurisdiction:            KDOT
Analysis Year:           2015
Description:  NEPA Traffic Study
```

_____Flow Inputs and Adjustments_____

Volume, V	1320	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	367	v
Trucks and buses	20	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.909	
Driver population factor, fp	1.00	
Flow rate, vp	807	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	807	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	11.5	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

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_____Operational Analysis_____

```
Analyst:                 Tom Hiles
Agency or Company:       HDR Inc.
Date Performed:          4/3/2008 1:55:41 PM
Analysis Time Period:    PM
Freeway/Direction:       I-35 Northbound
From/To:                 US 56 to 151st Street
Jurisdiction:            KDOT
Analysis Year:           2015
Description:  NEPA Traffic Study
```

_____Flow Inputs and Adjustments_____

Volume, V	2390	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	664	v
Trucks and buses	12	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.943	
Driver population factor, fp	1.00	
Flow rate, vp	1407	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	1407	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	20.1	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

2015 Gardner IMF Operations + Induced Development - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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_______________Operational Analysis_______________

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/3/2008 1:55:41 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: 151Street to US 56
Jurisdiction: KDOT
Analysis Year: 2015
Description: NEPA Traffic Study

_______________Flow Inputs and Adjustments_______________

Volume, V	3840	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1067	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	2229	pc/h/ln

_______________Speed Inputs and Adjustments_______________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______________LOS and Performance Measures_______________

Flow rate, vp	2229	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	59.3	mi/h
Number of lanes, N	2	
Density, D	37.6	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

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_______________Operational Analysis_______________

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/3/2008 1:55:41 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: US 56 to Gardner Road
Jurisdiction: KDOT
Analysis Year: 2015
Description: NEPA Traffic Study

_______________Flow Inputs and Adjustments_______________

Volume, V	2620	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	728	v
Trucks and buses	13	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.939	
Driver population factor, fp	1.00	
Flow rate, vp	1550	pc/h/ln

_______________Speed Inputs and Adjustments_______________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______________LOS and Performance Measures_______________

Flow rate, vp	1550	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	69.6	mi/h
Number of lanes, N	2	
Density, D	22.3	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

2015 Gardner IMF Operations + Induced Development - PM Peak Hour - HCS Freeway Mainline

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Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/3/2008 1:55:41 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	Gardner Road to Sunflower Road
Jurisdiction:	KDOT
Analysis Year:	2015
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	1940	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	539	v
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.948	
Driver population factor, fp	1.00	
Flow rate, vp	1137	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	1137	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	16.2	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/3/2008 1:55:41 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	Sunflower Road to Edgerton Road
Jurisdiction:	
Analysis Year:	2015
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	1560	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	433	v
Trucks and buses	13	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.939	
Driver population factor, fp	1.00	
Flow rate, vp	923	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	923	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	13.2	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2015 Gardner IMF Operations + Induced Development - AM Peak Hour - HCS Freeway Ramps

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Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                 Tom Hiles
Agency/Co.:              HDR Inc.
Date performed:          4/3/2008 1:55:41 PM
Analysis time period:    AM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                1 Sunflower Exit
Jurisdiction:            KDOT
Analysis Year:           2015
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0            mph
Volume on freeway                           1325            vph

_________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0            mph
Volume on ramp                              25              vph
Length of first accel/decel lane            800             ft
Length of second accel/decel lane                           ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                     vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                   ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1325        25                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 368         7                    v
Trucks and buses                        10          4                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.952       0.943
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1546        29                        pcph

_________________________Estimation of V12 Diverge Areas________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1546   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                1546          4800            No
      Fi   F
     v  = v - v            1517          4800            No
      FO   F   R
     v                     29            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1546          4600                   No
      12                                                                        !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   10.3    pc/mi/ln
                                          R          12        D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                  D  = 0.431
                                               S
Space mean speed in ramp influence area,      S  = 57.9    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 57.9    mph
________________________________________________________________________________
```

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_________________________________Merge Analysis_________________________________

Analyst:                 Tom Hiles
Agency/Co.:              HDR Inc.
Date performed:          4/3/2008 1:55:41 PM
Analysis time period:    AM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                2 Sunflower Entr
Jurisdiction:            KDOT
Analysis Year:           2015
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0            mph
Volume on freeway                           1300            vph

__________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0            mph
Volume on ramp                              430             vph
Length of first accel/decel lane            800             ft
Length of second accel/decel lane                           ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                     vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                   ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1300        430                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 361         119                  v
Trucks and buses                        10          1                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.952       0.985
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1517        485                       pcph

_________________________Estimation of V12 Merge Areas__________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1517   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     2002          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

_________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1517          4400                   No
      12                                                                        !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   15.9    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                  M  = 0.294
                                               S
Space mean speed in ramp influence area,      S  = 61.8    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 61.8    mph
________________________________________________________________________________
```

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E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1730           vph

________________________________Off Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0           mph
Volume on ramp                             140            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1730        140                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                481         39                   v
Trucks and buses                       8           4                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.962       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1999        165                  pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1999   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1999          4800            No
      Fi   F
     v  = v - v            1834          4800            No
      FO   F   R
     v                     165           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1999          4600                   No
      12                                                                  !
_________________Level of Service Determination (if not F)____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   14.2    pc/mi/ln
                        R                12         D
Level of service for ramp-freeway junction areas of influence B

_______________________________Speed Estimation_______________________________

Intermediate speed variable,                D  = 0.443
                                             S
Space mean speed in ramp influence area,    S  = 57.6    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.6    mph
______________________________________________________________________________
```

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________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1590           vph

_________________________________On Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             820            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1590        820                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                442         228                  v
Trucks and buses                       8           13                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.962       0.837
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1837        1089                 pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1837   pc/h
                   12   F   FM

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2926          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1837          4400                   No
      12                                                                  !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   22.8    pc/mi/ln
              R                 R          12            A
Level of service for ramp-freeway junction areas of influence  C

_______________________________Speed Estimation_______________________________

Intermediate speed variable,                M  = 0.338
                                             S
Space mean speed in ramp influence area,    S  = 60.5    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 60.5    mph
______________________________________________________________________________
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2015 Gardner IMF Operations + Induced Development - AM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_______________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

________________________________Freeway Data_________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2410          vph

_______________________________Off Ramp Data________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              280           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

__________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway    Ramp       Adjacent
                                                              Ramp
Volume, V (vph)                         2410       280                 vph
Peak-hour factor, PHF                   0.90       0.90
Peak 15-min volume, v15                 669        78                  v
Trucks and buses                        10         7                   %
Recreational vehicles                   0          0                   %
Terrain type:                           Level      Rolling
     Grade                              0.00   %   0.00    %           %
     Length                             0.00   mi  0.00    mi          mi
Trucks and buses PCE, ET                1.5*       2.5
Recreational vehicle PCE, ER            1.2*       2.0
```

```
Heavy vehicle adjustment, fHV           0.952      0.905
Driver population factor, fP            1.00       1.00
Flow rate, vp                           2812       344                  pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2812   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v  = v                2812          4800            No
      Fi   F
     v  = v - v            2468          4800            No
      FO   F   R
     v                     344           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                2812          4600                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   21.2    pc/mi/ln
                         R                 12         D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation________________________________

Intermediate speed variable,                D  = 0.459
                                             S
Space mean speed in ramp influence area,    S  = 57.1     mph
                                             R
Space mean speed in outer lanes,            S  =  N/A     mph
                                             0
Space mean speed for all vehicles,          S  = 57.1     mph
_____________________________________________________________________________
```

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_______________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           3780          vph

________________________________On Ramp Data________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              140           vph
Length of first accel/decel lane            1000          ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

__________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway    Ramp       Adjacent
                                                              Ramp
Volume, V (vph)                         3780       140                 vph
Peak-hour factor, PHF                   0.90       0.90
Peak 15-min volume, v15                 1050       39                  v
Trucks and buses                        10         2                   %
Recreational vehicles                   0          0                   %
Terrain type:                           Level      Rolling
     Grade                                     %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET                1.5*       2.5
Recreational vehicle PCE, ER            1.2*       2.0
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```
Heavy vehicle adjustment, fHV           0.952      0.971
Driver population factor, fP            1.00       1.00
Flow rate, vp                           4410       160                  pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  4410   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     4570          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                4410          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   34.8    pc/mi/ln
                              R            12            A
Level of service for ramp-freeway junction areas of influence  D

_____________________________Speed Estimation________________________________

Intermediate speed variable,                M  = 0.628
                                             S
Space mean speed in ramp influence area,    S  = 52.4     mph
                                             R
Space mean speed in outer lanes,            S  =  N/A     mph
                                             0
Space mean speed for all vehicles,          S  = 52.4     mph
_____________________________________________________________________________
```

2015 Gardner IMF Operations + Induced Development - AM Peak Hour - HCS Freeway Ramps

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                      HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
E-mail:

________________________________Merge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                        Merge
Number of lanes in freeway              2
Free-flow speed on freeway              70.0          mph
Volume on freeway                       2130          vph

_________________________________On Ramp Data_______________________________

Side of freeway                         Right
Number of lanes in ramp                 1
Free-flow speed on ramp                 35.0          mph
Volume on ramp                          1650          vph
Length of first accel/decel lane        500           ft
Length of second accel/decel lane                     ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?               No
Volume on adjacent Ramp                               vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                             ft

___________________Conversion to pc/h Under Base Conditions_________________

Junction Components                 Freeway     Ramp        Adjacent
                                                            Ramp
Volume, V (vph)                     2130        1650                  vph
Peak-hour factor, PHF               0.90        0.90
Peak 15-min volume, v15             592         458                   v
Trucks and buses                    10          2                     %
Recreational vehicles               0           0                     %
Terrain type:                       Level       Rolling
    Grade                                   %           %           %
    Length                                 mi          mi          mi
Trucks and buses PCE, ET            1.5*        2.5
Recreational vehicle PCE, ER        1.2*        2.0
Heavy vehicle adjustment, fHV           0.952       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2485        1888                    pcph

_________________________Estimation of V12 Merge Areas______________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2485   pc/h
                   12   F   FM

_______________________________Capacity Checks______________________________

                           Actual        Maximum         LOS F?
     v                     4373          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area__________________
                      Actual        Max Desirable          Violation?
     v                2485          4400                   No
      12                                                                   !
________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   35.6    pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  E

_____________________________Speed Estimation_______________________________

Intermediate speed variable,              M  = 0.595
                                           S
Space mean speed in ramp influence area,  S  = 53.3    mph
                                           R
Space mean speed in outer lanes,          S  =  N/A    mph
                                           0
Space mean speed for all vehicles,        S  = 53.3    mph
____________________________________________________________________________
```

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                      HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
E-mail:

________________________________Diverge Analysis____________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               8 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                        Diverge
Number of lanes in freeway              2
Free-flow speed on freeway              70.0          mph
Volume on freeway                       2010          vph

________________________________Off Ramp Data_______________________________

Side of freeway                         Right
Number of lanes in ramp                 1
Free-Flow speed on ramp                 45.0          mph
Volume on ramp                          1220          vph
Length of first accel/decel lane        800           ft
Length of second accel/decel lane                     ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?               No
Volume on adjacent ramp                               vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                             ft

___________________Conversion to pc/h Under Base Conditions_________________

Junction Components                 Freeway     Ramp        Adjacent
                                                            Ramp
Volume, V (vph)                     2010        1220                  vph
Peak-hour factor, PHF               0.90        0.90
Peak 15-min volume, v15             558         339                   v
Trucks and buses                    11          4                     %
Recreational vehicles               0           0                     %
Terrain type:                       Level       Rolling
    Grade                           0.00    %   0.00    %           %
    Length                          0.00   mi   0.00   mi          mi
Trucks and buses PCE, ET            1.5*        2.5
Recreational vehicle PCE, ER        1.2*        2.0
Heavy vehicle adjustment, fHV           0.948       0.943
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2356        1437                    pcph

_________________________Estimation of V12 Diverge Areas____________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2356   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks______________________________

                           Actual        Maximum         LOS F?
     v  = v                2356          4800            No
      Fi   F
     v  = v - v            919           4800            No
      FO   F   R
     v                     1437          2100            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area__________________
                      Actual        Max Desirable          Violation?
     v                2356          4600                   No
      12                                                                   !
________________Level of Service Determination (if not F)___________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   17.3    pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation_______________________________

Intermediate speed variable,              D  = 0.427
                                           S
Space mean speed in ramp influence area,  S  = 58.0    mph
                                           R
Space mean speed in outer lanes,          S  =  N/A    mph
                                           0
Space mean speed for all vehicles,        S  = 58.0    mph
____________________________________________________________________________
```

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Phone:                                  Fax:
E-mail:

_________________________________Merge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               9 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          790           vph

__________________________________On Ramp Data_______________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0          mph
Volume on ramp                             100           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        790         100                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                219         28                    v
Trucks and buses                       11          13                    %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.948       0.837
Driver population factor, fP           1.00        1.00
Flow rate, vp                          926         133                      pcph

_________________________Estimation of V12 Merge Areas_______________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  926    pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     1059          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area__________________
                      Actual        Max Desirable          Violation?
     v                926           4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   8.7     pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  A

______________________________Speed Estimation_______________________________

Intermediate speed variable,                 M  = 0.276
                                              S
Space mean speed in ramp influence area,     S  = 62.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.3    mph
_____________________________________________________________________________
```

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                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                  Fax:
E-mail:

_________________________________Diverge Analysis____________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          890           vph

_________________________________Off Ramp Data_______________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0          mph
Volume on ramp                             330           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        890         330                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                247         92                    v
Trucks and buses                       21          23                    %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.905       0.743
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1093        493                      pcph

_________________________Estimation of V12 Diverge Areas_____________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1093   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v  = v                1093          4800            No
      Fi   F
     v  = v - v            600           4800            No
      FO   F   R
     v                     493           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area__________________
                      Actual        Max Desirable          Violation?
     v                1093          4600                   No
      12                                                                     !
_________________Level of Service Determination (if not F)___________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =    6.5     pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence A

______________________________Speed Estimation_______________________________

Intermediate speed variable,                 D  = 0.472
                                              S
Space mean speed in ramp influence area,     S  = 56.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 56.8    mph
_____________________________________________________________________________
```

2015 Gardner IMF Operations + Induced Development - AM Peak Hour - HCS Freeway Ramps

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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

________________________________Merge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         560            vph

_________________________________On Ramp Data_______________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0           mph
Volume on ramp                            70             vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       560         70                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               156         19                   v
Trucks and buses                      21          10                   %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
    Grade                                     %           %           %
    Length                                    mi          mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.905       0.870
Driver population factor, fP          1.00        1.00
Flow rate, vp                         688         89                   pcph

_________________________Estimation of V12 Merge Areas______________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  688    pc/h
                   12   F   FM

______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     777           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area__________________
                      Actual        Max Desirable        Violation?
     v                688           4400                 No
      12                                                                  !
________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   6.5     pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  A

____________________________Speed Estimation________________________________

Intermediate speed variable,                 M  = 0.273
                                              S
Space mean speed in ramp influence area,     S  = 62.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.3    mph
____________________________________________________________________________
```

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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

________________________________Diverge Analysis____________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         630            vph

________________________________Off Ramp Data_______________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0           mph
Volume on ramp                            90             vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       630         90                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               175         25                   v
Trucks and buses                      19          2                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
    Grade                             0.00    %   0.00    %           %
    Length                            0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.913       0.971
Driver population factor, fP          1.00        1.00
Flow rate, vp                         767         103                  pcph

_________________________Estimation of V12 Diverge Areas____________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  767    pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v  = v                767           4800            No
      Fi   F
     v  = v - v            664           4800            No
      FO   F   R
     v                     103           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area__________________
                      Actual        Max Desirable        Violation?
     v                767           4600                 No
      12                                                                  !
________________Level of Service Determination (if not F)___________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   3.6     pc/mi/ln
                                         R           12           D
Level of service for ramp-freeway junction areas of influence A

____________________________Speed Estimation________________________________

Intermediate speed variable,                 D  = 0.437
                                              S
Space mean speed in ramp influence area,     S  = 57.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.8    mph
____________________________________________________________________________
```

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Phone: Fax:
E-mail:

Merge Analysis

Analyst: Tom Hiles
Agency/Co.: HDR Inc.
Date performed: 4/3/2008 1:55:41 PM
Analysis time period: AM
Freeway/Dir of Travel: I-35 Southbound
Junction: 13 Sunflower Entr
Jurisdiction: KDOT
Analysis Year: 2015
Description: NEPA Traffic Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	540	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	25	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	540	25		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	150	7		v
Trucks and buses	19	0		%
Recreational vehicles	0	0		%
Terrain type:	Level	Rolling		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5*	2.5		
Recreational vehicle PCE, ER	1.2*	2.0		
Heavy vehicle adjustment, fHV	0.913	1.000		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	657	28		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 657 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	685	4800	No
v_{3} or v_{av34}	0 pc/h	(Equation 25-4 or 25-5)	
Is v_{3} or v_{av34} > 2700 pc/h?		No	
Is v_{3} or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} =		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	657	4400	No

!

Level of Service Determination (if not F)

Density, $D = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 5.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable, M_S = 0.273

Space mean speed in ramp influence area, S_R = 62.4 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 62.4 mph

```
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Phone:                                    Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          795           vph

________________________________Off Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0          mph
Volume on ramp                             25            vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       795         25                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               221         7                   v
Trucks and buses                      21          0                   %
Recreational vehicles                 0           0                   %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %           %
     Length                           0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.905       1.000
Driver population factor, fP           1.00        1.00
Flow rate, vp                          976         28                        pcph

________________________Estimation of V12 Diverge Areas________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  976    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                976           4800            No
      Fi   F
     v  = v - v            948           4800            No
      FO   F   R
     v                     28            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                976           4600                  No
      12                                                                         !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =    5.4     pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence A

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.431
                                              S
Space mean speed in ramp influence area,     S  = 57.9    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.9    mph
________________________________________________________________________________
```

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Phone:                                    Fax:
E-mail:

________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          770           vph

_________________________________On Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0          mph
Volume on ramp                             160           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       770         160                 vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               214         44                  v
Trucks and buses                      21          3                   %
Recreational vehicles                 0           0                   %
Terrain type:                         Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.905       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          945         186                       pcph

________________________Estimation of V12 Merge Areas__________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  945    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1131          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                945           4400                  No
      12                                                                         !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =    9.2     pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  A

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.277
                                              S
Space mean speed in ramp influence area,     S  = 62.2    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.2    mph
________________________________________________________________________________
```

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Phone:                                      Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           930            vph

_________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              90             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        930         90                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                258         25                   v
Trucks and buses                       19          11                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.913       0.858
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1132        117                  pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1132   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1132          4800            No
      Fi   F
     v  = v - v            1015          4800            No
      FO   F   R
     v                     117           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable           Violation?
     v                1132          4600                    No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =    6.8     pc/mi/ln
                        R                 12         D
Level of service for ramp-freeway junction areas of influence A

_______________________________Speed Estimation________________________________

Intermediate speed variable,                 D  = 0.439
                                              S
Space mean speed in ramp influence area,     S  = 57.7    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.7    mph
_______________________________________________________________________________
```

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Phone:                                      Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           840            vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              480            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        840         480                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                233         133                  v
Trucks and buses                       19          21                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.913       0.760
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1022        701                  pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1022   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1723          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable           Violation?
     v                1022          4400                    No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =    13.6    pc/mi/ln
           R                 R            12           A
Level of service for ramp-freeway junction areas of influence  B

_______________________________Speed Estimation________________________________

Intermediate speed variable,                 M  = 0.287
                                              S
Space mean speed in ramp influence area,     S  = 62.0    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.0    mph
_______________________________________________________________________________
```

2015 Gardner IMF Operations + Induced Development - PM Peak Hour - HCS Freeway Ramps

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Phone:                                     Fax:
E-mail:

_________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1320           vph

_________________________________Off Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              150            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1320        150                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                367         42                    v
Trucks and buses                       20          9                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %             %
     Length                            0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.909       0.881
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1613        189                   pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1613   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                1613          4800            No
      Fi   F
     v  = v - v            1424          4800            No
      FO   F   R
     v                     189           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1613          4600                   No
      12                                                                    !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   10.9    pc/mi/ln
                         R                  12         D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.445
                                              S
Space mean speed in ramp influence area,     S  = 57.5    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.5    mph
_______________________________________________________________________________
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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                     Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           2370           vph

__________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              20             vph
Length of first accel/decel lane            1000           ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        2370        20                    vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                658         6                     v
Trucks and buses                       20          4                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                                     %           %             %
     Length                                    mi          mi            mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.909       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2897        24                    pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2897   pc/h
                   12   F   FM

______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     2921          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2897          4400                   No
      12                                                                    !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   22.0    pc/mi/ln
                              R            12           A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.323
                                              S
Space mean speed in ramp influence area,     S  = 60.9    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 60.9    mph
_______________________________________________________________________________
```

```
                       HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                     Fax:
E-mail:

________________________________Merge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1170           vph

_________________________________On Ramp Data_______________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             1200           vph
Length of first accel/decel lane           500            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1170        1200                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                325         333                  v
Trucks and buses                       20          4                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
    Grade                                     %           %            %
    Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.909       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1430        1413                 pcph

_________________________Estimation of V12 Merge Areas_______________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1430   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum        LOS F?
     v                     2843          4800           No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                1430          4400                 No
      12                                                                    !
_________________Level of Service Determination (if not F)__________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   23.9    pc/mi/ln
          R                  R          12             A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation________________________________

Intermediate speed variable,               M  = 0.353
                                            S
Space mean speed in ramp influence area,   S  = 60.1    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 60.1    mph
_____________________________________________________________________________
```

```
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Phone:                                     Fax:
E-mail:

________________________________Diverge Analysis____________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               8 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          3840           vph

________________________________Off Ramp Data_______________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    45.0           mph
Volume on ramp                             1590           vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        3840        1590                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                1067        442                  v
Trucks and buses                       9           3                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
    Grade                              0.00   %    0.00   %            %
    Length                             0.00   mi   0.00   mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.957       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          4459        1846                 pcph

_________________________Estimation of V12 Diverge Areas_____________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  4459   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_______________________________

                           Actual        Maximum        LOS F?
     v  = v                4459          4800           No
      Fi   F
     v  = v - v            2613          4800           No
      FO   F   R
     v                     1846          2100           No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable        Violation?
     v                4459          4600                 No
      12                                                                    !
_________________Level of Service Determination (if not F)__________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   35.4    pc/mi/ln
                       R                   12          D
Level of service for ramp-freeway junction areas of influence E

_____________________________Speed Estimation________________________________

Intermediate speed variable,               D  = 0.464
                                            S
Space mean speed in ramp influence area,   S  = 57.0    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 57.0    mph
_____________________________________________________________________________
```

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Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               9 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         2250          vph

__________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            370           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       2250        370                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               625         103                  v
Trucks and buses                      9           4                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
    Grade                                     %           %            %
    Length                                    mi          mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.957       0.943
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2613        436                  pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2613   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum        LOS F?
     v                     3049          4800           No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                2613          4400                   No
      12                                                                  !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v   + 0.0078 v   - 0.00627 L   =   24.0    pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,              M  = 0.347
                                           S
Space mean speed in ramp influence area,  S  = 60.3    mph
                                           R
Space mean speed in outer lanes,          S  =  N/A    mph
                                           0
Space mean speed for all vehicles,        S  = 60.3    mph
_______________________________________________________________________________
```

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                      HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         2620          vph

_________________________________Off Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            810           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       2620        810                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               728         225                  v
Trucks and buses                      13          17                   %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
    Grade                             0.00    %   0.00    %            %
    Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.939       0.797
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3100        1129                 pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  3100   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum        LOS F?
     v  = v                3100          4800           No
      Fi   F
     v  = v - v            1971          4800           No
      FO   F   R
     v                     1129          2000           No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

_______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                3100          4600                   No
      12                                                                  !
_________________Level of Service Determination (if not F)_____________________

Density,                D = 4.252 + 0.0086 v  - 0.009  L   =   23.7    pc/mi/ln
                                            R         12    D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,              D  = 0.530
                                           S
Space mean speed in ramp influence area,  S  = 55.2    mph
                                           R
Space mean speed in outer lanes,          S  =  N/A    mph
                                           0
Space mean speed for all vehicles,        S  = 55.2    mph
_______________________________________________________________________________
```

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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

________________________________Merge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1810          vph

_________________________________On Ramp Data________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            130           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1810        130                 vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               503         36                  v
Trucks and buses                      13          8                   %
Recreational vehicles                 0           0                   %
Terrain type:                         Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.939       0.893
Driver population factor, fP          1.00        1.00
Flow rate, vp                         2142        162                 pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2142   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum        LOS F?
     v                     2304          4800           No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                2142          4400                   No
      12                                                                    !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   18.4    pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation_________________________________

Intermediate speed variable,              M  = 0.304
                                           S
Space mean speed in ramp influence area,  S  = 61.5    mph
                                           R
Space mean speed in outer lanes,          S  =  N/A    mph
                                           0
Space mean speed for all vehicles,        S  = 61.5    mph
______________________________________________________________________________
```

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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

________________________________Diverge Analysis_____________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1940          vph

________________________________Off Ramp Data________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            420           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1940        420                 vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               539         117                 v
Trucks and buses                      11          1                   %
Recreational vehicles                 0           0                   %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %           %
     Length                           0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.948       0.985
Driver population factor, fP          1.00        1.00
Flow rate, vp                         2274        474                 pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2274   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                           Actual        Maximum        LOS F?
     v  = v                2274          4800           No
      Fi   F
     v  = v - v            1800          4800           No
      FO   F   R
     v                     474           2000           No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

_____________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                2274          4600                   No
      12                                                                    !
_________________Level of Service Determination (if not F)____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   16.6    pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation_________________________________

Intermediate speed variable,              D  = 0.471
                                           S
Space mean speed in ramp influence area,  S  = 56.8    mph
                                           R
Space mean speed in outer lanes,          S  =  N/A    mph
                                           0
Space mean speed for all vehicles,        S  = 56.8    mph
______________________________________________________________________________
```

2015 Gardner IMF Operations + Induced Development - PM Peak Hour - HCS Freeway Ramps

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                 HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/3/2008 1:55:41 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1520          vph

__________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              40            vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1520        40                    vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                422         11                    v
Trucks and buses                       11          5                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.948       0.930
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1782        48                    pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1782   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1830          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v     > 2700 pc/h?            No
      3 or  av34
Is   v     v     > 1.5 v  /2             No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1782          4400                   No
      12                                                                    !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   14.7    pc/mi/ln
          R                   R          12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.289
                                              S
Space mean speed in ramp influence area,     S  = 61.9    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.9    mph
_______________________________________________________________________________
```

2030 Gardner Proposed Action + Indirect Effects - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

________________________Operational Analysis_________________________________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:11:35 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Edgerton Road to Sunflower Road
Jurisdiction:	
Analysis Year:	2030
Description:	NEPA Traffic Study

________________________Flow Inputs and Adjustments__________________________

Volume, V	2400	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	667	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1393	pc/h/ln

________________________Speed Inputs and Adjustments_________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

________________________LOS and Performance Measures_________________________

Flow rate, vp	1393	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	19.9	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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________________________Operational Analysis_________________________________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:11:35 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Sunflower Road to Waverly Road
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

________________________Flow Inputs and Adjustments__________________________

Volume, V	2920	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	811	v
Trucks and buses	8	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.962	
Driver population factor, fp	1.00	
Flow rate, vp	1687	pc/h/ln

________________________Speed Inputs and Adjustments_________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

________________________LOS and Performance Measures_________________________

Flow rate, vp	1687	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	68.9	mi/h
Number of lanes, N	2	
Density, D	24.5	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

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_________________________Operational Analysis__________________________________

Analyst:                Tom Hiles
Agency or Company:      HDR Inc.
Date Performed:         4/1/2008 4:11:35 PM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Northbound
From/To:                Waverly Road to Gardner Road
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                   3360          veh/h
Peak-hour factor, PHF                       0.90
Peak 15-min volume, v15                     933           v
Trucks and buses                            12            %
Recreational vehicles                       0             %
Terrain type:                               Level
    Grade                                   0.00          %
    Segment length                          0.00          mi
Trucks and buses PCE, ET                    1.5
Recreational vehicle PCE, ER                1.2
Heavy vehicle adjustment, fHV               0.943
Driver population factor, fp                1.00
Flow rate, vp                               1319          pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                  12.0          ft
Right-shoulder lateral clearance            6.0           ft
Interchange density                         1.15          interchange/mi
Number of lanes, N                          3
Free-flow speed:                            Measured
     FFS or BFFS                            70.0          mi/h
Lane width adjustment, fLW                  0.0           mi/h
Lateral clearance adjustment, fLC           0.0           mi/h
Interchange density adjustment, fID         3.2           mi/h
Number of lanes adjustment, fN              0.0           mi/h
Free-flow speed, FFS                        70.0          mi/h
                                            Rural Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                               1319          pc/h/ln
Free-flow speed, FFS                        70.0          mi/h
Average passenger-car speed, S              70.0          mi/h
Number of lanes, N                          3
Density, D                                  18.8          pc/mi/ln
Level of service, LOS                       C

  Overall results are not computed when free-flow speed is less than 55 mph.
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_________________________Operational Analysis__________________________________

Analyst:                Tom Hiles
Agency or Company:      HDR Inc.
Date Performed:         4/1/2008 4:11:35 PM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Northbound
From/To:                Gardner Road to US 56
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                   4480          veh/h
Peak-hour factor, PHF                       0.90
Peak 15-min volume, v15                     1244          v
Trucks and buses                            9             %
Recreational vehicles                       0             %
Terrain type:                               Level
    Grade                                   0.00          %
    Segment length                          0.00          mi
Trucks and buses PCE, ET                    1.5
Recreational vehicle PCE, ER                1.2
Heavy vehicle adjustment, fHV               0.957
Driver population factor, fp                1.00
Flow rate, vp                               1734          pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                  12.0          ft
Right-shoulder lateral clearance            6.0           ft
Interchange density                         0.50          interchange/mi
Number of lanes, N                          3
Free-flow speed:                            Measured
     FFS or BFFS                            70.0          mi/h
Lane width adjustment, fLW                  0.0           mi/h
Lateral clearance adjustment, fLC           0.0           mi/h
Interchange density adjustment, fID         0.0           mi/h
Number of lanes adjustment, fN              3.0           mi/h
Free-flow speed, FFS                        70.0          mi/h
                                            Urban Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                               1734          pc/h/ln
Free-flow speed, FFS                        70.0          mi/h
Average passenger-car speed, S              68.5          mi/h
Number of lanes, N                          3
Density, D                                  25.3          pc/mi/ln
Level of service, LOS                       C

  Overall results are not computed when free-flow speed is less than 55 mph.
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2030 Gardner Proposed Action + Indirect Effects - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Level of service, LOS E

Overall results are not computed when free-flow speed is less than 55 mph.

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_______________________Operational Analysis_________________________________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:11:35 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	US 56 to 151st Street
Jurisdiction:	KDOT
Analysis Year:	2030

Description: NEPA Traffic Study

_______________________Flow Inputs and Adjustments__________________________

Volume, V	5760	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1600	v
Trucks and buses	8	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.962	
Driver population factor, fp	1.00	
Flow rate, vp	2219	pc/h/ln

_______________________Speed Inputs and Adjustments_________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_______________________LOS and Performance Measures_________________________

Flow rate, vp	2219	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	59.6	mi/h
Number of lanes, N	3	
Density, D	37.3	pc/mi/ln

HCS+: Basic Freeway Segments Release 5.21

Level of service, LOS C

Overall results are not computed when free-flow speed is less than 55 mph.

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_______________________Operational Analysis_________________________________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:11:35 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	151Street to US 56
Jurisdiction:	KDOT
Analysis Year:	2030

Description: NEPA Traffic Study

_______________________Flow Inputs and Adjustments__________________________

Volume, V	3700	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1028	v
Trucks and buses	12	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.943	
Driver population factor, fp	1.00	
Flow rate, vp	1453	pc/h/ln

_______________________Speed Inputs and Adjustments_________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_______________________LOS and Performance Measures_________________________

Flow rate, vp	1453	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	69.9	mi/h
Number of lanes, N	3	
Density, D	20.8	pc/mi/ln

2030 Gardner Proposed Action + Indirect Effects - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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_____Operational Analysis_____

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:11:35 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	US 56 to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2030

Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	2550	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	708	v
Trucks and buses	16	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.926	
Driver population factor, fp	1.00	
Flow rate, vp	1020	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	1020	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	14.6	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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_____Operational Analysis_____

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:11:35 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	Gardner Road to Waverly Road
Jurisdiction:	KDOT
Analysis Year:	2030

Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	1750	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	486	v
Trucks and buses	20	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.909	
Driver population factor, fp	1.00	
Flow rate, vp	713	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	1.15	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	3.2	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	713	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	10.2	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Gardner Proposed Action + Indirect Effects - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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_______Operational Analysis_______

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:11:35 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	Waverly Road to Sunflower Road
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

_______Flow Inputs and Adjustments_______

Volume, V	1280	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	356	v
Trucks and buses	19	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.913	
Driver population factor, fp	1.00	
Flow rate, vp	779	pc/h/ln

_______Speed Inputs and Adjustments_______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______LOS and Performance Measures_______

Flow rate, vp	779	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	11.1	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

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Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:11:35 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	Sunflower Road to Edgerton Road
Jurisdiction:	
Analysis Year:	2030
Description:	NEPA Traffic Study

_______Flow Inputs and Adjustments_______

Volume, V	1200	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	333	v
Trucks and buses	20	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.909	
Driver population factor, fp	1.00	
Flow rate, vp	733	pc/h/ln

_______Speed Inputs and Adjustments_______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______LOS and Performance Measures_______

Flow rate, vp	733	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	10.5	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

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_____Operational Analysis_____

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:11:35 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Northbound
From/To: Edgerton Road to Sunflower Road
Jurisdiction:
Analysis Year: 2030
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	1380	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	383	v
Trucks and buses	22	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.901	
Driver population factor, fp	1.00	
Flow rate, vp	851	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	851	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	12.2	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

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_____Operational Analysis_____

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:11:35 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Northbound
From/To: Sunflower Road to Waverly Road
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	1570	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	436	v
Trucks and buses	20	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.909	
Driver population factor, fp	1.00	
Flow rate, vp	959	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	959	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	13.7	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:11:35 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Waverly Road to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2030

Description: NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	2130	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	592	v
Trucks and buses	21	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.905	
Driver population factor, fp	1.00	
Flow rate, vp	872	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	1.15	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	3.2	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	872	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	12.5	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:11:35 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Gardner Road to US 56
Jurisdiction:	KDOT
Analysis Year:	2030

Description: NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	3020	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	839	v
Trucks and buses	16	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.926	
Driver population factor, fp	1.00	
Flow rate, vp	1208	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1208	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	17.3	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Gardner IMF Operations + Induced Development - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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____Operational Analysis____

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:11:35 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Northbound
From/To: US 56 to 151st Street
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

____Flow Inputs and Adjustments____

Volume, V	4410	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1225	v
Trucks and buses	12	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.943	
Driver population factor, fp	1.00	
Flow rate, vp	1731	pc/h/ln

____Speed Inputs and Adjustments____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

____LOS and Performance Measures____

Flow rate, vp	1731	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	68.5	mi/h
Number of lanes, N	3	
Density, D	25.3	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

____Operational Analysis____

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:11:35 PM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: 151Street to US 56
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

____Flow Inputs and Adjustments____

Volume, V	5560	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1544	v
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.948	
Driver population factor, fp	1.00	
Flow rate, vp	2173	pc/h/ln

____Speed Inputs and Adjustments____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

____LOS and Performance Measures____

Flow rate, vp	2173	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	60.9	mi/h
Number of lanes, N	3	
Density, D	35.7	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Gardner IMF Operations + Induced Development - PM Peak Hour - HCS Freeway Mainline

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                    HCS+: Basic Freeway Segments Release 5.21

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E-mail:

_________________________Operational Analysis__________________________________

Analyst:                Tom Hiles
Agency or Company:      HDR Inc.
Date Performed:         4/1/2008 4:11:35 PM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Southbound
From/To:                US 56 to Gardner Road
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                   4790          veh/h
Peak-hour factor, PHF                       0.90
Peak 15-min volume, v15                     1331          v
Trucks and buses                            12            %
Recreational vehicles                       0             %
Terrain type:                               Level
    Grade                                   0.00          %
    Segment length                          0.00          mi
Trucks and buses PCE, ET                    1.5
Recreational vehicle PCE, ER                1.2
Heavy vehicle adjustment, fHV               0.943
Driver population factor, fp                1.00
Flow rate, vp                               1881          pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                  12.0          ft
Right-shoulder lateral clearance            6.0           ft
Interchange density                         0.50          interchange/mi
Number of lanes, N                          3
Free-flow speed:                            Measured
     FFS or BFFS                            70.0          mi/h
Lane width adjustment, fLW                  0.0           mi/h
Lateral clearance adjustment, fLC           0.0           mi/h
Interchange density adjustment, fID         0.0           mi/h
Number of lanes adjustment, fN              3.0           mi/h
Free-flow speed, FFS                        70.0          mi/h
                                            Urban Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                               1881          pc/h/ln
Free-flow speed, FFS                        70.0          mi/h
Average passenger-car speed, S              66.8          mi/h
Number of lanes, N                          3
Density, D                                  28.1          pc/mi/ln
Level of service, LOS                       D

  Overall results are not computed when free-flow speed is less than 55 mph.
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                    HCS+: Basic Freeway Segments Release 5.21

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_________________________Operational Analysis__________________________________

Analyst:                Tom Hiles
Agency or Company:      HDR Inc.
Date Performed:         4/1/2008 4:11:35 PM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Southbound
From/To:                Gardner Road to Waverly Road
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                   3640          veh/h
Peak-hour factor, PHF                       0.90
Peak 15-min volume, v15                     1011          v
Trucks and buses                            15            %
Recreational vehicles                       0             %
Terrain type:                               Level
    Grade                                   0.00          %
    Segment length                          0.00          mi
Trucks and buses PCE, ET                    1.5
Recreational vehicle PCE, ER                1.2
Heavy vehicle adjustment, fHV               0.930
Driver population factor, fp                1.00
Flow rate, vp                               1449          pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                  12.0          ft
Right-shoulder lateral clearance            6.0           ft
Interchange density                         1.15          interchange/mi
Number of lanes, N                          3
Free-flow speed:                            Measured
     FFS or BFFS                            70.0          mi/h
Lane width adjustment, fLW                  0.0           mi/h
Lateral clearance adjustment, fLC           0.0           mi/h
Interchange density adjustment, fID         3.2           mi/h
Number of lanes adjustment, fN              3.0           mi/h
Free-flow speed, FFS                        70.0          mi/h
                                            Urban Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                               1449          pc/h/ln
Free-flow speed, FFS                        70.0          mi/h
Average passenger-car speed, S              69.9          mi/h
Number of lanes, N                          3
Density, D                                  20.7          pc/mi/ln
Level of service, LOS                       C

  Overall results are not computed when free-flow speed is less than 55 mph.
```

Level of service, LOS	D

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:11:35 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	Waverly Road to Sunflower Road
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	3190	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	886	v
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.948	
Driver population factor, fp	1.00	
Flow rate, vp	1870	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1870	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	67.0	mi/h
Number of lanes, N	2	
Density, D	27.9	pc/mi/ln

Level of service, LOS	C

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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E-mail:

Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:11:35 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	Sunflower Road to Edgerton Road
Jurisdiction:	
Analysis Year:	2030
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	2720	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	756	v
Trucks and buses	13	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.939	
Driver population factor, fp	1.00	
Flow rate, vp	1609	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1609	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	69.4	mi/h
Number of lanes, N	2	
Density, D	23.2	pc/mi/ln

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                      HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2400          vph

_________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              160           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2400        160                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 667         44                   v
Trucks and buses                        9           6                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
    Grade                               0.00    %   0.00    %            %
    Length                              0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.957       0.917
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2787        194                      pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2787   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                2787          4800            No
      Fi   F
     v  = v - v            2593          4800            No
      FO   F   R
     v                     194           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                2787          4600                   No
      12                                                                      !
________________Level of Service Determination (if not F)____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   21.0    pc/mi/ln
                      R                  12          D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.445
                                              S
Space mean speed in ramp influence area,     S  = 57.5    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.5    mph
________________________________________________________________________________
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                      HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2240          vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              680           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2240        680                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 622         189                  v
Trucks and buses                        9           2                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
    Grade                                       %           %            %
    Length                                      mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.957       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2601        778                      pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2601   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     3379          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                2601          4400                   No
      12                                                                      !
________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   26.5    pc/mi/ln
          R                   R          12             A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.379
                                              S
Space mean speed in ramp influence area,     S  = 59.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 59.4    mph
________________________________________________________________________________
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                      HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Waverly Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           2920           vph

_________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              330            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        2920        330                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                811         92                   v
Trucks and buses                       8           3                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.962       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3374        383                  pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  3374   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                            Actual        Maximum         LOS F?
     v  = v                 3374          4800            No
      Fi   F
     v  = v - v             2991          4800            No
      FO   F   R
     v                      383           2000            No
      R
     v     v                0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?            No
      3 or  av34
Is   v     v      > 1.5 v  /2             No
      3 or  av34        12
If yes, v    =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                       Actual        Max Desirable          Violation?
     v                 3374          4600                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   26.1    pc/mi/ln
                        R                 12         D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.462
                                              S
Space mean speed in ramp influence area,     S  = 57.1    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.1    mph
_______________________________________________________________________________
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                      HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Waverly Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           2590           vph

__________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              770            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        2590        770                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                719         214                  v
Trucks and buses                       8           22                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.962       0.752
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2993        1138                 pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1796   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                            Actual        Maximum         LOS F?
     v                      4131          7200            No
      FO
     v     v                1197 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?            No
      3 or  av34
Is   v     v      > 1.5 v  /2             No
      3 or  av34        12
If yes, v    =                            (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area_____________________
                       Actual        Max Desirable          Violation?
     v                 1796          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   22.8    pc/mi/ln
           R                  R            12            A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.338
                                              S
Space mean speed in ramp influence area,     S  = 60.5    mph
                                              R
Space mean speed in outer lanes,             S  = 67.5    mph
                                              0
Space mean speed for all vehicles,           S  = 62.4    mph
_______________________________________________________________________________
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2030 Gardner IMF Operations + Induced Development - AM Peak Hour - HCS Freeway Ramps

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                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                 Tom Hiles
Agency/Co.:              HDR Inc.
Date performed:          4/1/2008 4:11:35 PM
Analysis time period:    AM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                5 Gardner Exit
Jurisdiction:            KDOT
Analysis Year:           2030
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           3360           vph

_________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              400            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        3360        400                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                933         111                  v
Trucks and buses                       12          2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.943       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3957        458                  pcph

_________________________Estimation of V12 Diverge Areas________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.640   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  2697   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                3957          7200            No
      Fi   F
     v  = v - v            3499          7200            No
      FO   F   R
     v                     458           2000            No
      R
     v     v               1260 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

_____________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2697          4600                   No
      12                                                                        !
_________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   20.2    pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence C

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.469
                                              S
Space mean speed in ramp influence area,     S  = 56.9    mph
                                              R
Space mean speed in outer lanes,             S  = 75.8    mph
                                              0
Space mean speed for all vehicles,           S  = 61.8    mph
________________________________________________________________________________
```

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                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                 Tom Hiles
Agency/Co.:              HDR Inc.
Date performed:          4/1/2008 4:11:35 PM
Analysis time period:    AM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                6 Gardner Entr
Jurisdiction:            KDOT
Analysis Year:           2030
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           2960           vph

__________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              1520           vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        2960        1520                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                822         422                  v
Trucks and buses                       12          2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.943       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3486        1740                 pcph

_________________________Estimation of V12 Merge Areas__________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  2091   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     5226          7200            No
      FO
     v     v               1395 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2091          4400                   No
      12                                                                        !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   29.5    pc/mi/ln
          R                   R          12             A
Level of service for ramp-freeway junction areas of influence  D

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.445
                                              S
Space mean speed in ramp influence area,     S  = 57.5    mph
                                              R
Space mean speed in outer lanes,             S  = 66.8    mph
                                              0
Space mean speed for all vehicles,           S  = 59.8    mph
________________________________________________________________________________
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2030 Gardner IMF Operations + Induced Development - AM Peak Hour - HCS Freeway Ramps

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                   HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           4480           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              860            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         4480        860                 vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 1244        239                 v
Trucks and buses                        9           4                   %
Recreational vehicles                   0           0                   %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %           %
     Length                             0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.957       0.943
Driver population factor, fP            1.00        1.00
Flow rate, vp                           5202        1013                pcph

_________________________Estimation of V12 Diverge Areas________________________

                  L  =           (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.583   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  3457   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                            Actual        Maximum        LOS F?
     v  = v                 5202          7200           No
      Fi   F
     v  = v - v             4189          7200           No
      FO   F   R
     v                      1013          2000           No
      R
     v     v                1745 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?            No
      3 or  av34
Is   v     v      > 1.5 v  /2             No
      3 or  av34         12
If yes, v    =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_______________________
                       Actual        Max Desirable         Violation?
     v                 3457          4600                  No
      12                                                                        !
_________________Level of Service Determination (if not F)_______________________

Density,           D = 4.252 + 0.0086 v  - 0.009  L   =   26.8    pc/mi/ln
                                       R              12        D
Level of service for ramp-freeway junction areas of influence C

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.519
                                              S
Space mean speed in ramp influence area,     S  = 55.5    mph
                                              R
Space mean speed in outer lanes,             S  = 73.9    mph
                                              0
Space mean speed for all vehicles,           S  = 60.5    mph
________________________________________________________________________________
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                   HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               8 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           5250           vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              510            vph
Length of first accel/decel lane            1000           ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         5250        510                 vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 1458        142                 v
Trucks and buses                        9           2                   %
Recreational vehicles                   0           0                   %
Terrain type:                           Level       Rolling
     Grade                                      %           %           %
     Length                                     mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.957       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           6096        584                 pcph

_________________________Estimation of V12 Merge Areas__________________________

                  L  =           (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.605   Using Equation  1
                   FM
                  v  = v  (P  ) =  3691   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                            Actual        Maximum        LOS F?
     v                      6680          7200           No
      FO
     v     v                2405 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?            No
      3 or  av34
Is   v     v      > 1.5 v  /2             No
      3 or  av34         12
If yes, v    =                            (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area_______________________
                       Actual        Max Desirable         Violation?
     v                 3691          4400                  No
      12                                                                        !
_________________Level of Service Determination (if not F)_______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   32.3    pc/mi/ln
                              R             12           A
Level of service for ramp-freeway junction areas of influence  D

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.531
                                              S
Space mean speed in ramp influence area,     S  = 55.1    mph
                                              R
Space mean speed in outer lanes,             S  = 62.8    mph
                                              0
Space mean speed for all vehicles,           S  = 57.7    mph
________________________________________________________________________________
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2030 Gardner IMF Operations + Induced Development - AM Peak Hour - HCS Freeway Ramps

```
                      HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis_________________________________

Analyst:                 Tom Hiles
Agency/Co.:              HDR Inc.
Date performed:          4/1/2008 4:11:35 PM
Analysis time period:    AM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                9 Loop Ramp Entr
Jurisdiction:            KDOT
Analysis Year:           2030
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           3620           vph

__________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              1630           vph
Length of first accel/decel lane            500            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)______________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        3620        1630                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                1006        453                  v
Trucks and buses                       9           2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.957       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          4203        1865                    pcph

_________________________Estimation of V12 Merge Areas__________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.591   Using Equation  1
                   FM
                  v  = v  (P  ) =  2486   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     6068          7200            No
      FO
     v     v               1717 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                2486          4400                   No
      12                                                                   !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   35.4    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  E

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                M  = 0.588
                                             S
Space mean speed in ramp influence area,    S  = 53.5    mph
                                             R
Space mean speed in outer lanes,            S  = 65.6    mph
                                             0
Space mean speed for all vehicles,          S  = 56.5    mph
________________________________________________________________________________
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                      HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

________________________________Diverge Analysis________________________________

Analyst:                 Tom Hiles
Agency/Co.:              HDR Inc.
Date performed:          4/1/2008 4:11:35 PM
Analysis time period:    AM
Freeway/Dir of Travel:   I-35 Southbound
Junction:                10 US 56 Exit
Jurisdiction:            KDOT
Analysis Year:           2030
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           3700           vph

________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     2
Free-Flow speed on ramp                     45.0           mph
Volume on ramp                              1580           vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane           500            ft

________________________Adjacent Ramp Data (if one exists)______________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        3700        1580                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                1028        439                  v
Trucks and buses                       12          3                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00   %    0.00   %           %
     Length                            0.00   mi   0.00   mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.943       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          4358        1835                    pcph

_________________________Estimation of V12 Diverge Areas________________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.450   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2970   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                4358          7200            No
      Fi   F
     v  = v - v            2523          7200            No
      FO   F   R
     v                     1835          4100            No
      R
     v     v               1388 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                2970          4600                   No
      12                                                                   !
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   10.9    pc/mi/ln
                                          R          12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                D  = 0.463
                                             S
Space mean speed in ramp influence area,    S  = 57.0    mph
                                             R
Space mean speed in outer lanes,            S  = 75.3    mph
                                             0
Space mean speed for all vehicles,          S  = 61.8    mph
________________________________________________________________________________
```

2030 Gardner IMF Operations + Induced Development - AM Peak Hour - HCS Freeway Ramps

```
                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data______________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2110          vph

__________________________________On Ramp Data______________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              420           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2110        420                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 586         117                  v
Trucks and buses                        12          7                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.943       0.905
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2485        516                     pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1491   pc/h
                   12   F   FM

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
    v                      3001          7200            No
     FO
    v     v                994  pc/h     (Equation 25-4 or 25-5)
     3 or  av34
Is   v     v       > 2700 pc/h?          No
     3 or  av34
Is   v     v       > 1.5 v  /2           No
     3 or  av34           12
If yes, v    =                           (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
    v                 1491          4400                   No
     12                                                                   !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   15.9    pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  B

____________________________Speed Estimation__________________________________

Intermediate speed variable,              M  = 0.294
                                           S
Space mean speed in ramp influence area,  S  = 61.8    mph
                                           R
Space mean speed in outer lanes,          S  = 68.2    mph
                                           0
Space mean speed for all vehicles,        S  = 63.8    mph
_______________________________________________________________________________
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Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis____________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data______________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2550          vph

_________________________________Off Ramp Data______________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              870           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2550        870                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 708         242                  v
Trucks and buses                        16          7                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.926       0.905
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3060        1068                    pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.634   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  2332   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
    v  = v                 3060          7200            No
     Fi   F
    v  = v - v             1992          7200            No
     FO   F   R
    v                      1068          2000            No
     R
    v     v                728  pc/h     (Equation 25-15 or 25-16)
     3 or  av34
Is   v     v       > 2700 pc/h?          No
     3 or  av34
Is   v     v       > 1.5 v  /2           No
     3 or  av34           12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable          Violation?
    v                 2332          4600                   No
     12                                                                   !
_________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   17.1    pc/mi/ln
                                          R         12          D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation__________________________________

Intermediate speed variable,              D  = 0.524
                                           S
Space mean speed in ramp influence area,  S  = 55.3    mph
                                           R
Space mean speed in outer lanes,          S  = 76.8    mph
                                           0
Space mean speed for all vehicles,        S  = 59.3    mph
_______________________________________________________________________________
```

2030 Gardner IMF Operations + Induced Development - AM Peak Hour - HCS Freeway Ramps

```
                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                      Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1570          vph

_________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              180           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1570        180                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 436         50                   v
Trucks and buses                        16          3                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.926       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1884        209                     pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =           (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1130   pc/h
                   12   F   FM

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2093          7200            No
      FO
     v     v               754  pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34        12
If yes, v    =                           (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1130          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   10.8    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                M  = 0.280
                                             S
Space mean speed in ramp influence area,    S  = 62.2    mph
                                             R
Space mean speed in outer lanes,            S  = 69.1    mph
                                             0
Space mean speed for all vehicles,          S  = 64.5    mph
______________________________________________________________________________
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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                      Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               14 Waverly Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1750          vph

________________________________Off Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              580           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1750        580                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 486         161                  v
Trucks and buses                        20          19                   %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.909       0.778
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2139        828                     pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =           (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.668   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  1704   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                2139          7200            No
      Fi   F
     v  = v - v            1311          7200            No
      FO   F   R
     v                     828           2000            No
      R
     v     v               435  pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34        12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area__________________
                      Actual        Max Desirable          Violation?
     v                1704          4600                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density,                D = 4.252 + 0.0086 v  - 0.009  L   =   11.7    pc/mi/ln
                                         R          12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                D  = 0.503
                                             S
Space mean speed in ramp influence area,    S  = 55.9    mph
                                             R
Space mean speed in outer lanes,            S  = 76.8    mph
                                             0
Space mean speed for all vehicles,          S  = 59.2    mph
______________________________________________________________________________
```

2030 Gardner IMF Operations + Induced Development - AM Peak Hour - HCS Freeway Ramps

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                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis______________________________

Analyst:                 Tom Hiles
Agency/Co.:              HDR Inc.
Date performed:          4/1/2008 4:11:35 PM
Analysis time period:    AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:                15 Waverly Entr
Jurisdiction:            KDOT
Analysis Year:           2030
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          1160          vph

__________________________________On Ramp Data_______________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0          mph
Volume on ramp                             120           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1160        120                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                322         33                    v
Trucks and buses                       20          6                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                                     %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.909       0.917
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1418        145                    pcph

_________________________Estimation of V12 Merge Areas_______________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1418   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
    v                      1563          4800            No
     FO
    v     v                0    pc/h     (Equation 25-4 or 25-5)
     3 or  av34
Is   v     v      > 2700 pc/h?           No
     3 or  av34
Is   v     v      > 1.5 v  /2            No
     3 or  av34          12
If yes, v    =                           (Equation 25-8)
        12A

________________________Flow Entering Merge Influence Area___________________
                      Actual        Max Desirable          Violation?
    v                 1418          4400                   No
     12                                                                      !
_________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   12.6    pc/mi/ln
          R                   R           12           A
Level of service for ramp-freeway junction areas of influence  B

____________________________Speed Estimation_________________________________

Intermediate speed variable,                M  = 0.284
                                             S
Space mean speed in ramp influence area,    S  = 62.1    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 62.1    mph
_____________________________________________________________________________
```

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Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis_____________________________

Analyst:                 Tom Hiles
Agency/Co.:              HDR Inc.
Date performed:          4/1/2008 4:11:35 PM
Analysis time period:    AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:                16 Sunflower Exit
Jurisdiction:            KDOT
Analysis Year:           2030
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          1280          vph

_________________________________Off Ramp Data_______________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0          mph
Volume on ramp                             170           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1280        170                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                356         47                    v
Trucks and buses                       19          4                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %           %
     Length                            0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

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Heavy vehicle adjustment, fHV          0.913       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1557        200                    pcph

_________________________Estimation of V12 Diverge Areas_____________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1557   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
    v  = v                 1557          4800            No
     Fi   F
    v  = v - v             1357          4800            No
     FO   F   R
    v                      200           2000            No
     R
    v     v                0    pc/h     (Equation 25-15 or 25-16)
     3 or  av34
Is   v     v      > 2700 pc/h?           No
     3 or  av34
Is   v     v      > 1.5 v  /2            No
     3 or  av34          12
If yes, v    =                           (Equation 25-18)
        12A

______________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable          Violation?
    v                 1557          4600                   No
     12                                                                      !
_________________Level of Service Determination (if not F)___________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   10.4    pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation_________________________________

Intermediate speed variable,                D  = 0.446
                                             S
Space mean speed in ramp influence area,    S  = 57.5    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.5    mph
_____________________________________________________________________________
```

2030 Gardner IMF Operations + Induced Development - AM Peak Hour - HCS Freeway Ramps

HCS+: Ramps and Ramp Junctions Release 5.21

Phone: Fax:
E-mail:

Merge Analysis

Analyst: Tom Hiles
Agency/Co.: HDR Inc.
Date performed: 4/1/2008 4:11:35 PM
Analysis time period: AM
Freeway/Dir of Travel: I-35 Southbound
Junction: 17 Sunflower Entr
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1110	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	90	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1110	90		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	308	25		v
Trucks and buses	19	2		%
Recreational vehicles	0	0		%
Terrain type:	Level	Rolling		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5*	2.5		
Recreational vehicle PCE, ER	1.2*	2.0		
Heavy vehicle adjustment, fHV	0.913	0.971		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	1351	103		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1351 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1454	4800	No
v_{3} or v_{av34}	0 pc/h	(Equation 25-4 or 25-5)	
Is v_{3} or v_{av34} > 2700 pc/h?		No	
Is v_{3} or v_{av34} > 1.5 v_{12} /2		No	
If yes, v_{12A} =		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1351	4400	No

!

Level of Service Determination (if not F)

Density, $D = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 11.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, M_S = 0.282

Space mean speed in ramp influence area, S_R = 62.1 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 62.1 mph

```
                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1380           vph

_________________________________Off Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              90             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1380        90                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                383         25                   v
Trucks and buses                       22          2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.901       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1702        103                  pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1702   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1702          4800            No
      Fi   F
     v  = v - v            1599          4800            No
      FO   F   R
     v                     103           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1702          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,            D = 4.252 + 0.0086 v  - 0.009  L   =   11.7    pc/mi/ln
                      R                 12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                  D  = 0.437
                                               S
Space mean speed in ramp influence area,      S  = 57.8    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 57.8    mph
_______________________________________________________________________________
```

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Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1290           vph

__________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              280            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1290        280                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                358         78                   v
Trucks and buses                       22          4                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.901       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1591        330                  pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1591   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1921          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                1591          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   15.3    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                  M  = 0.292
                                               S
Space mean speed in ramp influence area,      S  = 61.8    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 61.8    mph
_______________________________________________________________________________
```

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Waverly Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         1570           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0           mph
Volume on ramp                            130            vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

_________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1570        130                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               436         36                    v
Trucks and buses                      20          8                     %
Recreational vehicles                 0           0                     %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %             %
     Length                           0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.909       0.893
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1919        162                   pcph

_________________________Estimation of V12 Diverge Areas________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1919   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum        LOS F?
     v  = v                1919          4800           No
      Fi   F
     v  = v - v            1757          4800           No
      FO   F   R
     v                     162           2000           No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                1919          4600                  No
      12                                                                     !
_________________Level of Service Determination (if not F)_____________________

Density,            D = 4.252 + 0.0086 v  - 0.009  L   =   13.6    pc/mi/ln
                     R                  12          D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.443
                                              S
Space mean speed in ramp influence area,     S  = 57.6    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.6    mph
________________________________________________________________________________
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Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Waverly Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                          Merge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0           mph
Volume on freeway                         1440           vph

__________________________________On Ramp Data___________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0           mph
Volume on ramp                            690            vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

_________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1440        690                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               400         192                   v
Trucks and buses                      20          23                    %
Recreational vehicles                 0           0                     %
Terrain type:                         Level       Rolling
     Grade                                    %           %             %
     Length                                   mi          mi            mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.909       0.743
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1760        1031                  pcph

_________________________Estimation of V12 Merge Areas__________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1056   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum        LOS F?
     v                     2791          7200           No
      FO
     v     v               704  pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                1056          4400                  No
      12                                                                     !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   16.3    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.296
                                              S
Space mean speed in ramp influence area,     S  = 61.7    mph
                                              R
Space mean speed in outer lanes,             S  = 69.3    mph
                                              0
Space mean speed for all vehicles,           S  = 63.4    mph
________________________________________________________________________________
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Phone:                                     Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 3
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          2130           vph

________________________________Off Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0           mph
Volume on ramp                             200            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        2130        200                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                592         56                   v
Trucks and buses                       21          6                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.905       0.917
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2615        242                  pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =           (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.683   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  1864   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v  = v                2615          7200            No
      Fi   F
     v  = v - v            2373          7200            No
      FO   F   R
     v                     242           2000            No
      R
     v     v               751  pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1864          4600                   No
      12                                                                      !
________________Level of Service Determination (if not F)_____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   13.1    pc/mi/ln
                      R                 12          D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation_________________________________

Intermediate speed variable,                 D  = 0.450
                                              S
Space mean speed in ramp influence area,     S  = 57.4     mph
                                              R
Space mean speed in outer lanes,             S  = 76.8     mph
                                              0
Space mean speed for all vehicles,           S  = 61.9     mph
_______________________________________________________________________________
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Phone:                                     Fax:
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________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Merge
Number of lanes in freeway                 3
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1930           vph

_________________________________On Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             1090           vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1930        1090                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                536         303                  v
Trucks and buses                       21          4                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.905       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2370        1284                 pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =           (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1422   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v                     3654          7200            No
      FO
     v     v               948  pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                1422          4400                   No
      12                                                                      !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   21.0    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  C

______________________________Speed Estimation_________________________________

Intermediate speed variable,                 M  = 0.323
                                              S
Space mean speed in ramp influence area,     S  = 60.9     mph
                                              R
Space mean speed in outer lanes,             S  = 68.4     mph
                                              0
Space mean speed for all vehicles,           S  = 62.7     mph
_______________________________________________________________________________
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_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           3020          vph

_________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              500           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        3020        500                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                839         139                   v
Trucks and buses                       16          8                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %             %
     Length                            0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.926       0.893
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3624        622                   pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.641   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  2546   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                3624          7200            No
      Fi   F
     v  = v - v            3002          7200            No
      FO   F   R
     v                     622           2000            No
      R
     v     v               1078 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2546          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,            D = 4.252 + 0.0086 v  - 0.009  L   =   18.9    pc/mi/ln
                                         R           12        D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.484
                                               S
Space mean speed in ramp influence area,     S  = 56.4    mph
                                               R
Space mean speed in outer lanes,             S  = 76.5    mph
                                               0
Space mean speed for all vehicles,           S  = 61.2    mph
_________________________________________________________________________________
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_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               8 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           3840          vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              570           vph
Length of first accel/decel lane            1000          ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        3840        570                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                1067        158                   v
Trucks and buses                       16          4                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                                     %           %             %
     Length                                    mi          mi            mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.926       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          4608        671                   pcph

_________________________Estimation of V12 Merge Areas__________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.605   Using Equation  1
                   FM
                  v  = v  (P  ) =  2790   pc/h
                   12   F   FM

______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     5279          7200            No
      FO
     v     v               1818 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2790          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L  =   25.9    pc/mi/ln
          R               R          12              A
Level of service for ramp-freeway junction areas of influence  C

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.375
                                               S
Space mean speed in ramp influence area,     S  = 59.5    mph
                                               R
Space mean speed in outer lanes,             S  = 65.3    mph
                                               0
Space mean speed for all vehicles,           S  = 61.4    mph
_________________________________________________________________________________
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2030 Gardner IMF Operations + Induced Development - PM Peak Hour - HCS Freeway Ramps

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                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Merge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               9 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                          Merge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0          mph
Volume on freeway                         2520          vph

_________________________________On Ramp Data_______________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            1320          vph
Length of first accel/decel lane          500           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

___________________Conversion to pc/h Under Base Conditions_________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        2520        1320                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                700         367                  v
Trucks and buses                       16          4                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.926       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3024        1555                 pcph

________________________Estimation of V12 Merge Areas_______________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.591   Using Equation  1
                   FM
                  v  = v  (P  ) =  1789   pc/h
                   12   F   FM

_______________________________Capacity Checks______________________________

                           Actual        Maximum         LOS F?
     v                     4579          7200            No
      FO
     v     v               1235 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area__________________
                      Actual        Max Desirable          Violation?
     v                1789          4400                   No
      12                                                                   !
_________________Level of Service Determination (if not F)__________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   27.7    pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  C

____________________________Speed Estimation________________________________

Intermediate speed variable,                 M  = 0.396
                                              S
Space mean speed in ramp influence area,     S  = 58.9    mph
                                              R
Space mean speed in outer lanes,             S  = 67.4    mph
                                              0
Space mean speed for all vehicles,           S  = 61.0    mph
____________________________________________________________________________
```

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                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis____________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                          Diverge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0          mph
Volume on freeway                         5560          vph

________________________________Off Ramp Data_______________________________

Side of freeway                           Right
Number of lanes in ramp                   2
Free-Flow speed on ramp                   45.0          mph
Volume on ramp                            1700          vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane         500           ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

___________________Conversion to pc/h Under Base Conditions_________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        5560        1700                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                1544        472                  v
Trucks and buses                       11          3                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00   %    0.00   %           %
     Length                            0.00   mi   0.00   mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
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Heavy vehicle adjustment, fHV          0.948       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          6518        1974                 pcph

________________________Estimation of V12 Diverge Areas_____________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.450   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  4019   pc/h
                   12   R      F   R   FD

_______________________________Capacity Checks______________________________

                           Actual        Maximum         LOS F?
     v  = v                6518          7200            No
      Fi   F
     v  = v - v            4544          7200            No
      FO   F   R
     v                     1974          4100            No
      R
     v     v               2499 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area__________________
                      Actual        Max Desirable          Violation?
     v                4019          4600                   No
      12                                                                   !
_________________Level of Service Determination (if not F)__________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   19.9    pc/mi/ln
                        R                 12          D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation________________________________

Intermediate speed variable,                 D  = 0.476
                                              S
Space mean speed in ramp influence area,     S  = 56.7    mph
                                              R
Space mean speed in outer lanes,             S  = 70.9    mph
                                              0
Space mean speed for all vehicles,           S  = 61.4    mph
____________________________________________________________________________
```

2030 Gardner IMF Operations + Induced Development - PM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           3860          vph

__________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              930           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)______________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         3860        930                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 1072        258                  v
Trucks and buses                        11          3                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                     %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.948       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           4525        1080                   pcph

_________________________Estimation of V12 Merge Areas__________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  2715   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     5605          7200            No
      FO
     v     v               1810 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area________________________
                      Actual        Max Desirable          Violation?
     v                2715          4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   29.6    pc/mi/ln
          R                   R            12             A
Level of service for ramp-freeway junction areas of influence  D

____________________________Speed Estimation____________________________________

Intermediate speed variable,                 M  = 0.438
                                              S
Space mean speed in ramp influence area,     S  = 57.7    mph
                                              R
Space mean speed in outer lanes,             S  = 65.3    mph
                                              0
Space mean speed for all vehicles,           S  = 60.0    mph
_______________________________________________________________________________
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Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           4790          vph

_________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              1570          vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)______________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         4790        1570                 vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 1331        436                  v
Trucks and buses                        12          4                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00   %    0.00   %           %
     Length                             0.00   mi   0.00   mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.943       0.943
Driver population factor, fP            1.00        1.00
Flow rate, vp                           5642        1849                   pcph

_________________________Estimation of V12 Diverge Areas________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.534   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  3874   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                5642          7200            No
      Fi   F
     v  = v - v            3793          7200            No
      FO   F   R
     v                     1849          2000            No
      R
     v     v               1768 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                3874          4600                   No
      12                                                                       !
_________________Level of Service Determination (if not F)______________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   30.4    pc/mi/ln
                                        R           12         D
Level of service for ramp-freeway junction areas of influence D

____________________________Speed Estimation____________________________________

Intermediate speed variable,                 D  = 0.594
                                              S
Space mean speed in ramp influence area,     S  = 53.4    mph
                                              R
Space mean speed in outer lanes,             S  = 73.8    mph
                                              0
Space mean speed for all vehicles,           S  = 58.4    mph
_______________________________________________________________________________
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Phone:                                   Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Merge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0          mph
Volume on freeway                         3220          vph

_________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            420           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       3220        420                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               894         117                  v
Trucks and buses                      12          4                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.943       0.943
Driver population factor, fP          1.00        1.00
Flow rate, vp                         3792        495                   pcph

________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  2275   pc/h
                   12   F   FM

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     4287          7200            No
      FO
     v     v               1517 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                2275          4400                  No
      12                                                                     !
________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   21.8    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  C

____________________________Speed Estimation__________________________________

Intermediate speed variable,                M  = 0.327
                                             S
Space mean speed in ramp influence area,    S  = 60.8    mph
                                             R
Space mean speed in outer lanes,            S  = 66.3    mph
                                             0
Space mean speed for all vehicles,          S  = 62.7    mph
_______________________________________________________________________________
```

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Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               14 Waverly Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Diverge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0          mph
Volume on freeway                         3640          vph

________________________________Off Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            810           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       3640        810                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               1011        225                  v
Trucks and buses                      15          25                   %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %           %
     Length                           0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.930       0.727
Driver population factor, fP          1.00        1.00
Flow rate, vp                         4348        1237                  pcph

________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.594   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  3086   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                4348          7200            No
      Fi   F
     v  = v - v            3111          7200            No
      FO   F   R
     v                     1237          2000            No
      R
     v     v               1262 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

_____________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                3086          4600                  No
      12                                                                     !
________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   23.6    pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence C

____________________________Speed Estimation__________________________________

Intermediate speed variable,                D  = 0.539
                                             S
Space mean speed in ramp influence area,    S  = 54.9    mph
                                             R
Space mean speed in outer lanes,            S  = 75.8    mph
                                             0
Space mean speed for all vehicles,          S  = 59.7    mph
_______________________________________________________________________________
```

2030 Gardner IMF Operations + Induced Development - PM Peak Hour - HCS Freeway Ramps

```
                      HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
E-mail:

_________________________________Merge Analysis______________________________

Analyst:                 Tom Hiles
Agency/Co.:              HDR Inc.
Date performed:          4/1/2008 4:11:35 PM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Southbound
Junction:                15 Waverly Entr
Jurisdiction:            KDOT
Analysis Year:           2030
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                             Merge
Number of lanes in freeway                   2
Free-flow speed on freeway                   70.0          mph
Volume on freeway                            2830          vph

__________________________________On Ramp Data_______________________________

Side of freeway                              Right
Number of lanes in ramp                      1
Free-flow speed on ramp                      35.0          mph
Volume on ramp                               360           vph
Length of first accel/decel lane             800           ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                    No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2830        360                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 786         100                  v
Trucks and buses                        15          4                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %           %
     Length                                     mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.930       0.943
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3380        424                      pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  3380   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v                     3804          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34            12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                3380          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   29.9    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  D

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                M  = 0.440
                                             S
Space mean speed in ramp influence area,    S  = 57.7    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.7    mph
______________________________________________________________________________
```

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Phone:                                  Fax:
E-mail:

_________________________________Diverge Analysis____________________________

Analyst:                 Tom Hiles
Agency/Co.:              HDR Inc.
Date performed:          4/1/2008 4:11:35 PM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Southbound
Junction:                16 Sunflower Exit
Jurisdiction:            KDOT
Analysis Year:           2030
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                             Diverge
Number of lanes in freeway                   2
Free-flow speed on freeway                   70.0          mph
Volume on freeway                            3190          vph

_________________________________Off Ramp Data_______________________________

Side of freeway                              Right
Number of lanes in ramp                      1
Free-Flow speed on ramp                      35.0          mph
Volume on ramp                               660           vph
Length of first accel/decel lane             800           ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                    No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         3190        660                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 886         183                  v
Trucks and buses                        11          2                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %           %
     Length                             0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.948       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3739        755                      pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  3739   pc/h
                   12   R      F   R   FD

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v  = v                3739          4800            No
      Fi   F
     v  = v - v            2984          4800            No
      FO   F   R
     v                     755           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34            12
If yes, v    =                           (Equation 25-18)
         12A

_____________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                3739          4600                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   29.2    pc/mi/ln
                                          R           12          D
Level of service for ramp-freeway junction areas of influence D

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                D  = 0.496
                                             S
Space mean speed in ramp influence area,    S  = 56.1    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 56.1    mph
______________________________________________________________________________
```

2030 Gardner IMF Operations + Induced Development - PM Peak Hour - HCS Freeway Ramps

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                  HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
E-mail:

_________________________________Merge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:11:35 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               17 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           2530           vph

__________________________________On Ramp Data________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              190            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2530        190                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 703         53                    v
Trucks and buses                        11          4                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                                      %           %           %
     Length                                     mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.948       0.943
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2966        224                   pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2966   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                              Actual        Maximum         LOS F?
     v                        3190          4800            No
      FO
     v     v                  0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?             No
      3 or  av34
Is   v     v       > 1.5 v  /2              No
      3 or  av34         12
If yes, v    =                              (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                2966          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   25.2    pc/mi/ln
          R                    R           12            A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                  M  = 0.360
                                               S
Space mean speed in ramp influence area,      S  = 59.9    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 59.9    mph
______________________________________________________________________________
```

Appendix G:

Results of Operational Analysis
Wellsville North No Action,
Wellsville North Alternative, and
Future Wellsville North Alternative IMF Operations

Synchro Analysis

1. 2010 Wellsville North No Action
2. 2010 Wellsville North Alternative
3. 2015 Wellsville North No Action
4. 2015 Wellsville North Alternative
5. 2030 Wellsville North No Action
6. 2030 Wellsville North Alternative

HCS Analysis

1. 2010 Wellsville North No Action
2. 2010 Wellsville North Alternative
3. 2015 Wellsville North No Action
4. 2015 Wellsville North Alternative
5. 2030 Wellsville North No Action
6. 2030 Wellsville North Alternative

2010 Wellsville North No Action - AM Peak Hour - Synchro Intersection LOS

1: 175th Street & Waverly Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	60	290	5	0	50	50	5	80	5	90	20	10
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	72	349	6	0	60	60	6	96	6	108	24	12
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	120			355			611	617	352	642	590	90
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	120			355			611	617	352	642	590	90
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.6	6.3
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.4
p0 queue free %	95			100			98	75	99	63	94	99
cM capacity (veh/h)	1449			1214			370	384	696	296	395	946

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	428	120	108	145
Volume Left	72	0	6	108
Volume Right	6	60	6	12
cSH	1449	1214	393	329
Volume to Capacity	0.05	0.00	0.28	0.44
Queue Length 95th (ft)	4	0	28	54
Control Delay (s)	1.7	0.0	17.6	24.3
Lane LOS	A		C	C
Approach Delay (s)	1.7	0.0	17.6	24.3
Approach LOS			C	C

Intersection Summary			
Average Delay	7.7		
Intersection Capacity Utilization	45.5%	ICU Level of Service	A
Analysis Period (min)	15		

2: US 56 & Gardner Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	550	60	100	210	100	70	320	190	140	200	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.99			0.96		1.00	0.94		1.00	0.99	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3393			3188		1805	1725		1736	1808	
Flt Permitted		0.89			0.63		0.60	1.00		0.25	1.00	
Satd. Flow (perm)		3043			2020		1144	1725		460	1808	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	46	632	69	115	241	115	80	368	218	161	230	23
RTOR Reduction (vph)	0	16	0	0	64	0	0	31	0	0	5	0
Lane Group Flow (vph)	0	731	0	0	407	0	80	555	0	161	248	0
Heavy Vehicles (%)	3%	5%	2%	7%	9%	6%	0%	4%	4%	4%	4%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		17.7			17.7		19.4	19.4		19.4	19.4	
Effective Green, g (s)		17.7			17.7		19.4	19.4		19.4	19.4	
Actuated g/C Ratio		0.36			0.36		0.40	0.40		0.40	0.40	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1104			733		455	686		183	719	
v/s Ratio Prot								0.32			0.14	
v/s Ratio Perm		c0.24			0.20		0.07			c0.35		
v/c Ratio		0.66			0.55		0.18	0.81		0.88	0.34	
Uniform Delay, d1		13.0			12.4		9.5	13.1		13.6	10.3	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.5			0.9		0.2	7.0		34.7	0.3	
Delay (s)		14.5			13.3		9.7	20.0		48.3	10.5	
Level of Service		B			B		A	C		D	B	
Approach Delay (s)		14.5			13.3			18.8			25.2	
Approach LOS		B			B			B			C	

Intersection Summary			
HCM Average Control Delay	17.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	48.8	Sum of lost time (s)	11.7
Intersection Capacity Utilization	86.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

8: US-56 & I-35 SB Ramps

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	1710	40	20	470	0	0	0	0	50	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	0	1800	42	21	495	0	0	0	0	53	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		986										
pX, platoon unblocked				0.65			0.65	0.65	0.65	0.65	0.65	
vC, conflicting volume	495			1842			2111	2358	921	1437	2379	247
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	495			1229			1639	2018	0	608	2050	247
tC, single (s)	4.1			4.3			7.5	6.5	6.9	7.7	6.5	7.0
tC, 2 stage (s)												
tF (s)	2.2			2.3			3.5	4.0	3.3	3.6	4.0	3.3
p0 queue free %	100			94			100	100	100	77	100	100
cM capacity (veh/h)	1079			340			42	36	713	226	35	750

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	SB 1	SB 2
Volume Total	1200	642	21	247	247	53	0
Volume Left	0	0	21	0	0	53	0
Volume Right	0	42	0	0	0	0	0
cSH	1700	1700	340	1700	1700	226	1700
Volume to Capacity	0.71	0.38	0.06	0.15	0.15	0.23	0.00
Queue Length 95th (ft)	0	0	5	0	0	22	0
Control Delay (s)	0.0	0.0	16.3	0.0	0.0	25.7	0.0
Lane LOS			C			D	A
Approach Delay (s)	0.0		0.7			25.7	
Approach LOS						D	

Intersection Summary			
Average Delay	0.7		
Intersection Capacity Utilization	58.5%	ICU Level of Service	B
Analysis Period (min)	15		

9: US-56 & I-35 NB Ramps

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	350	0	0	350	130	150	0	90	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	0	398	0	0	398	148	170	0	102	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	545			398			869	943	199	773	869	472
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	545			398			869	943	199	773	869	472
tC, single (s)	4.1			4.1			7.7	6.5	7.0	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.6	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			28	100	87	100	100	100
cM capacity (veh/h)	1034			1172			236	265	803	255	292	544

Direction, Lane #	EB 1	EB 2	WB 1	NB 1
Volume Total	199	199	545	273
Volume Left	0	0	0	170
Volume Right	0	0	148	102
cSH	1700	1700	1700	321
Volume to Capacity	0.12	0.12	0.32	0.85
Queue Length 95th (ft)	0	0	0	188
Control Delay (s)	0.0	0.0	0.0	55.9
Lane LOS				F
Approach Delay (s)	0.0		0.0	55.9
Approach LOS				F

Intersection Summary			
Average Delay	12.5		
Intersection Capacity Utilization	91.3%	ICU Level of Service	F
Analysis Period (min)	15		

2010 Wellsville North No Action - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 No-Action Wellsville

11: Waverly Road & US 56

AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✥			✥			✥			✥	
Volume (veh/h)	0	20	0	10	5	10	60	250	0	5	80	10
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	25	0	13	6	13	76	316	0	6	101	13
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	604	595	316	601	589	108	114			316		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	604	595	316	601	589	108	114			316		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.3	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.4	2.2			2.2		
p0 queue free %	100	94	100	97	98	99	95			99		
cM capacity (veh/h)	385	396	729	378	400	925	1469			1255		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	25	32	392	120
Volume Left	0	13	76	6
Volume Right	0	13	0	13
cSH	396	502	1469	1255
Volume to Capacity	0.06	0.06	0.05	0.01
Queue Length 95th (ft)	5	5	4	0
Control Delay (s)	14.7	12.7	1.9	0.5
Lane LOS	B	B	A	A
Approach Delay (s)	14.7	12.7	1.9	0.5
Approach LOS	B	B		

Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	37.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Wellsville

13: 183rd Street & US 56

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✥			✥			✥			✥	
Volume (veh/h)	5	10	0	10	10	5	0	310	10	0	80	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	13	0	13	13	6	0	392	13	0	101	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	516	509	104	509	506	399	108			405		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	516	509	104	509	506	399	108			405		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	97	100	97	97	99	100			100		
cM capacity (veh/h)	459	470	956	468	472	655	1496			1165		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	19	32	405	108
Volume Left	6	13	0	0
Volume Right	0	6	13	6
cSH	466	498	1496	1165
Volume to Capacity	0.04	0.06	0.00	0.00
Queue Length 95th (ft)	3	5	0	0
Control Delay (s)	13.1	12.7	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	13.1	12.7	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	26.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Wellsville

16: Four Corners Road & US 56

AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✥			✥			✥			✥	
Volume (veh/h)	5	5	10	0	10	5	10	310	0	5	90	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	7	7	13	0	13	7	13	408	0	7	118	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	579	566	408	582	566	118	118			408		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	579	566	408	582	566	118	118			408		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	98	100	97	99	99			99		
cM capacity (veh/h)	412	430	648	409	430	939	1482			1162		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	26	20	421	125
Volume Left	7	0	13	7
Volume Right	13	7	0	0
cSH	510	525	1482	1162
Volume to Capacity	0.05	0.04	0.01	0.01
Queue Length 95th (ft)	4	3	1	0
Control Delay (s)	12.4	12.1	0.3	0.5
Lane LOS	B	B	A	A
Approach Delay (s)	12.4	12.1	0.3	0.5
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.3		
Intersection Capacity Utilization	31.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Wellsville

17: 191st Street & US 56

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✥			✥			✥			✥	
Volume (veh/h)	10	10	5	0	0	5	0	320	5	0	90	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	13	13	6	0	0	6	0	416	6	0	117	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	545	542	120	552	542	419	123			422		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	545	542	120	552	542	419	123			422		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	97	99	100	100	99	100			100		
cM capacity (veh/h)	447	450	937	435	450	639	1476			1148		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	32	6	422	123
Volume Left	13	0	0	0
Volume Right	6	6	6	6
cSH	501	639	1476	1148
Volume to Capacity	0.06	0.01	0.00	0.00
Queue Length 95th (ft)	5	1	0	0
Control Delay (s)	12.7	10.7	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	12.7	10.7	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	31.9%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Wellsville North No Action - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 No-Action Wellsville

24: Sunflower Road & US 56
AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	10	30	0	0	10	320	60	5	90	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	6	13	38	0	0	13	405	76	6	114	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	595	633	114	611	595	443	114			481		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	595	633	114	611	595	443	114			481		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	90	100	100	99			99		
cM capacity (veh/h)	414	394	944	390	414	619	1488			1092		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	25	38	494	120
Volume Left	6	38	13	6
Volume Right	13	0	76	0
cSH	566	390	1488	1092
Volume to Capacity	0.04	0.10	0.01	0.01
Queue Length 95th (ft)	4	8	1	0
Control Delay (s)	11.7	15.2	0.3	0.5
Lane LOS	B	C	A	A
Approach Delay (s)	11.7	15.2	0.3	0.5
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	35.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Wellsville

25: US 56 & 4th Street
AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	350	50	10	110	10	30
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	449	64	13	141	13	38
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			513		647	481
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			513		647	481
tC, single (s)			4.2		6.5	6.2
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.3
p0 queue free %			99		97	93
cM capacity (veh/h)			1013		418	583

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	513	154	51
Volume Left	0	13	13
Volume Right	64	0	38
cSH	1700	1013	531
Volume to Capacity	0.30	0.01	0.10
Queue Length 95th (ft)	0	1	8
Control Delay (s)	0.0	0.8	12.5
Lane LOS		A	B
Approach Delay (s)	0.0	0.8	12.5
Approach LOS			B

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	31.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Wellsville

28: I-35 SB Ramps & Sunflower Road
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	10	0	40	5	20	0	0	240	10
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	0	0	0	11	0	46	6	23	0	0	276	11
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	362	316	282	316	322	23	287			23		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	362	316	282	316	322	23	287			23		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	98	100	96	100			100		
cM capacity (veh/h)	569	600	762	619	596	1051	1286			1605		

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	57	29	287
Volume Left	11	6	0
Volume Right	46	0	11
cSH	922	1286	1700
Volume to Capacity	0.06	0.00	0.17
Queue Length 95th (ft)	5	0	0
Control Delay (s)	9.2	1.6	0.0
Lane LOS	A	A	
Approach Delay (s)	9.2	1.6	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	23.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Wellsville

29: I-35 NB Ramps & Sunflower Road
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	0	5	0	0	0	0	10	40	240	10	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	11	0	6	0	0	0	0	11	46	276	11	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	598	621	11	603	598	34	11			57		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	598	621	11	603	598	34	11			57		
tC, single (s)	7.2	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.6	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	100	99	100	100	100	100			82		
cM capacity (veh/h)	348	334	1075	355	344	1044	1621			1553		

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	17	57	287
Volume Left	11	0	276
Volume Right	6	46	0
cSH	449	1700	1553
Volume to Capacity	0.04	0.03	0.18
Queue Length 95th (ft)	3	0	16
Control Delay (s)	13.3	0.0	7.6
Lane LOS	B		A
Approach Delay (s)	13.3	0.0	7.6
Approach LOS	B		

Intersection Summary			
Average Delay	6.6		
Intersection Capacity Utilization	30.5%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Wellsville North No Action - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 No-Action Wellsville

31: US 56 & Edgerton Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	260	20	20	70	5	10	5	50	20	10	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	283	22	22	76	5	11	5	54	22	11	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	82			304			432	429	293	484	438	79
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	82			304			432	429	293	484	438	79
tC, single (s)	4.1			4.2			7.2	6.9	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.3			3.6	4.4	3.3	3.5	4.0	3.3
p0 queue free %	100			98			98	99	93	95	98	100
cM capacity (veh/h)	1529			1212			503	455	746	449	505	987

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	310	103	71	33
Volume Left	5	22	11	22
Volume Right	22	5	54	0
cSH	1529	1212	664	466
Volume to Capacity	0.00	0.02	0.11	0.07
Queue Length 95th (ft)	0	1	9	6
Control Delay (s)	0.2	1.8	11.1	13.3
Lane LOS	A	A	B	B
Approach Delay (s)	0.2	1.8	11.1	13.3
Approach LOS			B	B

Intersection Summary			
Average Delay	2.8		
Intersection Capacity Utilization	28.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Wellsville

32: 207th & Sunflower Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	110	5	0	5	20	50	0	5	120	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	0	139	6	0	6	25	63	0	6	152	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	285	278	152	418	278	63	152			63		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	285	278	152	418	278	63	152			63		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	84	99	100	99	98			100		
cM capacity (veh/h)	656	619	897	456	619	1007	1411			1552		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	139	13	89	158
Volume Left	0	6	25	6
Volume Right	139	6	0	0
cSH	897	628	1411	1552
Volume to Capacity	0.16	0.02	0.02	0.00
Queue Length 95th (ft)	14	2	1	0
Control Delay (s)	9.7	10.9	2.3	0.3
Lane LOS	A	B	A	A
Approach Delay (s)	9.7	10.9	2.3	0.3
Approach LOS	A	B		

Intersection Summary			
Average Delay	4.4		
Intersection Capacity Utilization	23.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Wellsville

33: 207th & COOP Rd

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	70	10	10	40	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	14	95	14	14	54	14
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	27				142	20
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	27				142	20
tC, single (s)	4.1				6.4	6.4
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.5
p0 queue free %	99				94	99
cM capacity (veh/h)	1600				848	1008

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	108	27	68
Volume Left	14	0	54
Volume Right	0	14	14
cSH	1600	1700	876
Volume to Capacity	0.01	0.02	0.08
Queue Length 95th (ft)	1	0	6
Control Delay (s)	1.0	0.0	9.5
Lane LOS	A		A
Approach Delay (s)	1.0	0.0	9.5
Approach LOS			A

Intersection Summary			
Average Delay	3.7		
Intersection Capacity Utilization	20.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Wellsville

34: 207th & Edgerton Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	10	0	0	5	10	0	5	0	70	5	5
Peak Hour Factor	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Hourly flow rate (vph)	8	15	0	0	8	15	0	8	0	106	8	8

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	23	23	8	121
Volume Left (vph)	8	0	0	106
Volume Right (vph)	0	15	0	8
Hadj (s)	0.07	-0.06	0.34	0.17
Departure Headway (s)	4.3	4.2	4.5	4.2
Degree Utilization, x	0.03	0.03	0.01	0.14
Capacity (veh/h)	812	836	783	848
Control Delay (s)	7.4	7.3	7.5	7.9
Approach Delay (s)	7.4	7.3	7.5	7.9
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.7		
HCM Level of Service	A		
Intersection Capacity Utilization	22.7%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Wellsville North No Action - AM Peak Hour - Synchro Intersection LOS

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	5	0	5	5	0	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	10	0	10	10	0	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			10		40	10
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			10		40	10
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		100	99
cM capacity (veh/h)			1623		971	1077

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	10	20	10
Volume Left	0	10	0
Volume Right	0	0	10
cSH	1700	1623	1077
Volume to Capacity	0.01	0.01	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	3.6	8.4
Lane LOS		A	A
Approach Delay (s)	0.0	3.6	8.4
Approach LOS			A

Intersection Summary			
Average Delay	3.9		
Intersection Capacity Utilization	14.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	0	0	0	5	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	0	0	0	10	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	0				0	0
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	0				0	0
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	99
cM capacity (veh/h)	1636				1029	1091

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	0	0	20
Volume Left	0	0	10
Volume Right	0	0	10
cSH	1700	1700	1059
Volume to Capacity	0.00	0.00	0.02
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	0.0	8.5
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.5
Approach LOS			A

Intersection Summary			
Average Delay	8.5		
Intersection Capacity Utilization	6.7%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Wellsville North No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

1: 175th Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	60	290	5	0	50	50	5	80	5	90	20	10
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	72	349	6	0	60	60	6	96	6	108	24	12
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	120			355			611	617	352	642	590	90
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	120			355			611	617	352	642	590	90
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.2	6.5	6.3
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.4
p0 queue free %	95			100			98	75	99	63	94	99
cM capacity (veh/h)	1449			1214			370	384	696	295	396	946

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	428	120	108	145
Volume Left	72	0	6	108
Volume Right	6	60	6	12
cSH	1449	1214	393	328
Volume to Capacity	0.05	0.00	0.28	0.44
Queue Length 95th (ft)	4	0	28	54
Control Delay (s)	1.7	0.0	17.6	24.4
Lane LOS	A		C	C
Approach Delay (s)	1.7	0.0	17.6	24.4
Approach LOS			C	C

Intersection Summary			
Average Delay	7.7		
Intersection Capacity Utilization	45.5%	ICU Level of Service	A
Analysis Period (min)	15		

2: US 56 & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	550	60	100	210	100	70	320	190	140	200	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.99			0.96		1.00	0.94		1.00	0.99	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3393			3188		1805	1725		1736	1808	
Flt Permitted		0.89			0.63		0.60	1.00		0.25	1.00	
Satd. Flow (perm)		3043			2020		1144	1725		460	1808	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	46	632	69	115	241	115	80	368	218	161	230	23
RTOR Reduction (vph)	0	16	0	0	64	0	0	31	0	0	5	0
Lane Group Flow (vph)	0	731	0	0	407	0	80	555	0	161	248	0
Heavy Vehicles (%)	3%	5%	2%	7%	9%	6%	0%	4%	4%	4%	4%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		17.7			17.7		19.4	19.4		19.4	19.4	
Effective Green, g (s)		17.7			17.7		19.4	19.4		19.4	19.4	
Actuated g/C Ratio		0.36			0.36		0.40	0.40		0.40	0.40	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1104			733		455	686		183	719	
v/s Ratio Prot								0.32			0.14	
v/s Ratio Perm		c0.24			0.20		0.07			c0.35		
v/c Ratio		0.66			0.55		0.18	0.81		0.88	0.34	
Uniform Delay, d1		13.0			12.4		9.5	13.1		13.6	10.3	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.5			0.9		0.2	7.0		34.7	0.3	
Delay (s)		14.5			13.3		9.7	20.0		48.3	10.5	
Level of Service		B			B		A	C		D	B	
Approach Delay (s)		14.5			13.3			18.8			25.2	
Approach LOS		B			B			B			C	

Intersection Summary			
HCM Average Control Delay	17.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	48.8	Sum of lost time (s)	11.7
Intersection Capacity Utilization	86.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

8: US-56 & I-35 SB Ramps

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1710	40	20	470	0	0	0	0	50	0	920
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		1.00		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3513		1641	3689					1641		2760
Flt Permitted		1.00		0.95	1.00					0.95		1.00
Satd. Flow (perm)		3513		1641	3689					1641		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1800	42	21	495	0	0	0	0	53	0	968
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	74
Lane Group Flow (vph)	0	1840	0	21	495	0	0	0	0	53	0	894
Heavy Vehicles (%)	0%	2%	20%	10%	3%	0%	0%	0%	0%	10%	0%	3%
Turn Type	Prot			Prot						custom		custom
Protected Phases	5	2		1	6							5
Permitted Phases										4		4
Actuated Green, G (s)		32.8		1.4	13.2					2.8		23.8
Effective Green, g (s)		32.8		1.4	13.2					2.8		23.8
Actuated g/C Ratio		0.63		0.03	0.25					0.05		0.46
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2216		44	936					88		1529
v/s Ratio Prot		c0.52		0.01	c0.13							c0.24
v/s Ratio Perm										0.03		0.09
v/c Ratio		0.83		0.48	0.53					0.60		0.58
Uniform Delay, d1		7.4		24.9	16.7					24.1		10.4
Progression Factor		1.00		1.00	1.00					1.00		1.00
Incremental Delay, d2		3.8		7.9	2.1					11.1		0.6
Delay (s)		11.2		32.9	18.9					35.1		11.0
Level of Service		B		C	B					D		B
Approach Delay (s)		11.2			19.4			0.0			12.3	
Approach LOS		B			B			A			B	

Intersection Summary			
HCM Average Control Delay	12.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	52.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	59.4%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

9: US-56 & I-35 NB Ramps

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	350	0	0	350	130	150	5	90	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			0.96			0.95				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3725			1807			1648				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3725			1807			1648				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	398	0	0	398	148	170	6	102	0	0	0
RTOR Reduction (vph)	0	0	0	0	28	0	0	61	0	0	0	0
Lane Group Flow (vph)	0	398	0	0	518	0	0	217	0	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	1%	2%	8%	0%	4%	0%	0%	0%
Turn Type							Perm					
Protected Phases		2			6			8				
Permitted Phases							8					
Actuated Green, G (s)		19.5			19.5			10.5				
Effective Green, g (s)		19.5			19.5			10.5				
Actuated g/C Ratio		0.49			0.49			0.26				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		1816			881			433				
v/s Ratio Prot		0.11			c0.29							
v/s Ratio Perm								0.13				
v/c Ratio		0.22			0.59			0.50				
Uniform Delay, d1		5.9			7.4			12.5				
Progression Factor		1.00			1.00			1.00				
Incremental Delay, d2		0.3			2.9			0.9				
Delay (s)		6.2			10.2			13.4				
Level of Service		A			B			B				
Approach Delay (s)		6.2			10.2			13.4			0.0	
Approach LOS		A			B			B			A	

Intersection Summary			
HCM Average Control Delay	9.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	40.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	91.3%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

2010 Wellsville North No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)
11: Waverly Road & US 56
AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	20	0	10	5	10	60	250	0	5	80	10
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	25	0	13	6	13	76	316	0	6	101	13
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	604	595	316	601	589	108	114			316		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	604	595	316	601	589	108	114			316		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.3	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.4	2.2			2.2		
p0 queue free %	100	94	100	97	98	99	95			99		
cM capacity (veh/h)	385	396	729	378	400	925	1469			1255		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	25	32	392	120
Volume Left	0	13	76	6
Volume Right	0	13	0	13
cSH	396	502	1469	1255
Volume to Capacity	0.06	0.06	0.05	0.01
Queue Length 95th (ft)	5	5	4	0
Control Delay (s)	14.7	12.7	1.9	0.5
Lane LOS	B	B	A	A
Approach Delay (s)	14.7	12.7	1.9	0.5
Approach LOS	B	B		

Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	37.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)
13: 183rd Street & US 56
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	10	5	10	10	5	0	310	10	0	80	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	13	6	13	13	6	0	392	13	0	101	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	516	509	104	516	506	399	108			405		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	516	509	104	516	506	399	108			405		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	97	99	97	97	99	100			100		
cM capacity (veh/h)	459	470	956	460	472	655	1496			1165		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	25	32	405	108
Volume Left	6	13	0	0
Volume Right	6	6	13	6
cSH	534	494	1496	1165
Volume to Capacity	0.05	0.06	0.00	0.00
Queue Length 95th (ft)	4	5	0	0
Control Delay (s)	12.1	12.8	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	12.1	12.8	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	26.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)
16: Four Corners Road & US 56
AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	10	0	10	5	10	310	0	5	90	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	7	7	13	0	13	7	13	408	0	7	118	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	579	566	408	582	566	118	118			408		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	579	566	408	582	566	118	118			408		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	98	100	97	99	99			99		
cM capacity (veh/h)	412	430	648	409	430	939	1482			1162		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	26	20	421	125
Volume Left	7	0	13	7
Volume Right	13	7	0	0
cSH	510	525	1482	1162
Volume to Capacity	0.05	0.04	0.01	0.01
Queue Length 95th (ft)	4	3	1	0
Control Delay (s)	12.4	12.1	0.3	0.5
Lane LOS	B	B	A	A
Approach Delay (s)	12.4	12.1	0.3	0.5
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.3		
Intersection Capacity Utilization	31.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)
17: 191st Street & US 56
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	10	10	5	0	0	5	0	320	5	0	90	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	13	13	6	0	0	6	0	416	6	0	117	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	545	542	120	552	542	419	123			422		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	545	542	120	552	542	419	123			422		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	97	99	100	100	99	100			100		
cM capacity (veh/h)	447	450	937	435	450	639	1476			1148		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	32	6	422	123
Volume Left	13	0	0	0
Volume Right	6	6	6	6
cSH	501	639	1476	1148
Volume to Capacity	0.06	0.01	0.00	0.00
Queue Length 95th (ft)	5	1	0	0
Control Delay (s)	12.7	10.7	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	12.7	10.7	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	31.9%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Wellsville North No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)

24: Sunflower Road & US 56

AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	10	30	0	0	10	320	60	5	90	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	6	13	38	0	0	13	405	76	6	114	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	595	633	114	611	595	443	114			481		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	595	633	114	611	595	443	114			481		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	90	100	100	99			99		
cM capacity (veh/h)	414	394	944	390	414	619	1488			1092		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	25	38	494	120
Volume Left	6	38	13	6
Volume Right	13	0	76	0
cSH	566	390	1488	1092
Volume to Capacity	0.04	0.10	0.01	0.01
Queue Length 95th (ft)	4	8	1	0
Control Delay (s)	11.7	15.2	0.3	0.5
Lane LOS	B	C	A	A
Approach Delay (s)	11.7	15.2	0.3	0.5
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	35.6%	ICU Level of Service	A
Analysis Period (min)	15		

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BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)

25: US 56 & 4th Street

AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	350	50	10	110	10	30
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	449	64	13	141	13	38
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			513		647	481
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			513		647	481
tC, single (s)			4.2		6.5	6.2
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.3
p0 queue free %			99		97	93
cM capacity (veh/h)			1013		418	583

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	513	154	51
Volume Left	0	13	13
Volume Right	64	0	38
cSH	1700	1013	531
Volume to Capacity	0.30	0.01	0.10
Queue Length 95th (ft)	0	1	8
Control Delay (s)	0.0	0.8	12.5
Lane LOS		A	B
Approach Delay (s)	0.0	0.8	12.5
Approach LOS			B

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	31.5%	ICU Level of Service	A
Analysis Period (min)	15		

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BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)

26: 199th Street & Four Corners Road

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	60	30	10	5	0
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	6	71	36	12	6	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	48				125	42
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	48				125	42
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	100
cM capacity (veh/h)	1573				871	1035

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	77	48	6
Volume Left	6	0	6
Volume Right	0	12	0
cSH	1573	1700	871
Volume to Capacity	0.00	0.03	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.6	0.0	9.2
Lane LOS	A		A
Approach Delay (s)	0.6	0.0	9.2
Approach LOS			A

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	17.3%	ICU Level of Service	A
Analysis Period (min)	15		

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BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)

27: 199th Street & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	60	20	10	5	20	40	10	230	10	30	60	30
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	67	22	11	6	22	45	11	258	11	34	67	34

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	101	73	281	135
Volume Left (vph)	67	6	11	34
Volume Right (vph)	11	45	11	34
Hadj (s)	0.11	-0.32	0.03	-0.07
Departure Headway (s)	5.1	4.7	4.5	4.6
Degree Utilization, x	0.14	0.10	0.35	0.17
Capacity (veh/h)	645	687	762	734
Control Delay (s)	8.9	8.2	10.0	8.6
Approach Delay (s)	8.9	8.2	10.0	8.6
Approach LOS	A	A	B	A

Intersection Summary			
Delay	9.3		
HCM Level of Service	A		
Intersection Capacity Utilization	37.2%	ICU Level of Service	A
Analysis Period (min)	15		

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2010 Wellsville North No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)
28: I-35 SB Ramps & Sunflower Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	10	0	40	5	20	0	0	240	10
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	0	0	0	11	0	46	6	23	0	0	276	11
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	362	316	282	316	322	23	287			23		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	362	316	282	316	322	23	287			23		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	98	100	96	100			100		
cM capacity (veh/h)	569	600	762	619	596	1051	1286			1605		

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	57	29	287
Volume Left	11	6	0
Volume Right	46	0	11
cSH	922	1286	1700
Volume to Capacity	0.06	0.00	0.17
Queue Length 95th (ft)	5	0	0
Control Delay (s)	9.2	1.6	0.0
Lane LOS	A	A	
Approach Delay (s)	9.2	1.6	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	23.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)
29: I-35 NB Ramps & Sunflower Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	0	5	0	0	0	0	10	40	240	10	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	11	0	6	0	0	0	0	11	46	276	11	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	598	621	11	603	598	34	11			57		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	598	621	11	603	598	34	11			57		
tC, single (s)	7.2	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.6	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	100	99	100	100	100	100			82		
cM capacity (veh/h)	348	334	1075	355	344	1044	1621			1553		

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	17	57	287
Volume Left	11	0	276
Volume Right	6	46	0
cSH	449	1700	1553
Volume to Capacity	0.04	0.03	0.18
Queue Length 95th (ft)	3	0	16
Control Delay (s)	13.3	0.0	7.6
Lane LOS	B		A
Approach Delay (s)	13.3	0.0	7.6
Approach LOS	B		

Intersection Summary			
Average Delay	6.6		
Intersection Capacity Utilization	30.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)
31: US 56 & Edgerton Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	260	20	20	70	5	10	5	50	20	10	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	283	22	22	76	5	11	5	54	22	11	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	82			304			432	429	293	484	438	79
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	82			304			432	429	293	484	438	79
tC, single (s)	4.1			4.2			7.2	6.9	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.3			3.6	4.4	3.3	3.5	4.0	3.3
p0 queue free %	100			98			98	99	93	95	98	100
cM capacity (veh/h)	1529			1212			503	455	746	449	505	987

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	310	103	71	33
Volume Left	5	22	11	22
Volume Right	22	5	54	0
cSH	1529	1212	664	466
Volume to Capacity	0.00	0.02	0.11	0.07
Queue Length 95th (ft)	0	1	9	6
Control Delay (s)	0.2	1.8	11.1	13.3
Lane LOS	A	A	B	B
Approach Delay (s)	0.2	1.8	11.1	13.3
Approach LOS			B	B

Intersection Summary			
Average Delay	2.8		
Intersection Capacity Utilization	28.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)
32: 207th & Sunflower Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	110	5	0	5	20	50	0	5	120	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	0	139	6	0	6	25	63	0	6	152	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	285	278	152	418	278	63	152			63		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	285	278	152	418	278	63	152			63		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	84	99	100	99	98			100		
cM capacity (veh/h)	656	619	897	456	619	1007	1411			1552		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	139	13	89	158
Volume Left	0	6	25	6
Volume Right	139	6	0	0
cSH	897	628	1411	1552
Volume to Capacity	0.16	0.02	0.02	0.00
Queue Length 95th (ft)	14	2	1	0
Control Delay (s)	9.7	10.9	2.3	0.3
Lane LOS	A	B	A	A
Approach Delay (s)	9.7	10.9	2.3	0.3
Approach LOS	A	B		

Intersection Summary			
Average Delay	4.4		
Intersection Capacity Utilization	23.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)

33: 207th & COOP Rd — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	70	10	10	40	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	14	95	14	14	54	14
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	27				142	20
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	27				142	20
tC, single (s)	4.1				6.4	6.4
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.5
p0 queue free %	99				94	99
cM capacity (veh/h)	1600				848	1008

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	108	27	68
Volume Left	14	0	54
Volume Right	0	14	14
cSH	1600	1700	876
Volume to Capacity	0.01	0.02	0.08
Queue Length 95th (ft)	1	0	6
Control Delay (s)	1.0	0.0	9.5
Lane LOS	A		A
Approach Delay (s)	1.0	0.0	9.5
Approach LOS			A

Intersection Summary			
Average Delay	3.7		
Intersection Capacity Utilization	20.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)

34: 207th & Edgerton Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	10	0	0	5	10	0	5	0	70	5	5
Peak Hour Factor	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Hourly flow rate (vph)	8	15	0	0	8	15	0	8	0	106	8	8

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	23	23	8	121
Volume Left (vph)	8	0	0	106
Volume Right (vph)	0	15	0	8
Hadj (s)	0.07	-0.06	0.34	0.17
Departure Headway (s)	4.3	4.2	4.5	4.2
Degree Utilization, x	0.03	0.03	0.01	0.14
Capacity (veh/h)	812	836	783	848
Control Delay (s)	7.4	7.3	7.5	7.9
Approach Delay (s)	7.4	7.3	7.5	7.9
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.7		
HCM Level of Service	A		
Intersection Capacity Utilization	22.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)

35: 207th & Evening Star Rd — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	5	0	5	5	0	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	10	0	10	10	0	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			10		40	10
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			10		40	10
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		100	99
cM capacity (veh/h)			1623		971	1077

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	10	20	10
Volume Left	0	10	0
Volume Right	0	0	10
cSH	1700	1623	1077
Volume to Capacity	0.01	0.01	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	3.6	8.4
Lane LOS		A	A
Approach Delay (s)	0.0	3.6	8.4
Approach LOS			A

Intersection Summary			
Average Delay	3.9		
Intersection Capacity Utilization	14.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)

36: 215th & Evening Star Rd — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	0	0	0	5	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	0	0	0	10	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	0				0	0
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	0				0	0
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	99
cM capacity (veh/h)	1636				1029	1091

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	0	0	20
Volume Left	0	0	10
Volume Right	0	0	10
cSH	1700	1700	1059
Volume to Capacity	0.00	0.00	0.02
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	0.0	8.5
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.5
Approach LOS			A

Intersection Summary			
Average Delay	8.5		
Intersection Capacity Utilization	6.7%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Wellsville North No Action - PM Peak Hour - Synchro Intersection LOS

1: 175th Street & Waverly Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	90	5	5	280	80	10	20	5	30	20	20
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	12	108	6	6	337	96	12	24	6	36	24	24
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	434			114			569	581	111	551	536	386
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	434			114			569	581	111	551	536	386
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			100			97	94	99	91	95	96
cM capacity (veh/h)	1137			1487			398	421	947	417	447	667

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	127	440	42	84
Volume Left	12	6	12	36
Volume Right	6	96	6	24
cSH	1137	1487	450	477
Volume to Capacity	0.01	0.00	0.09	0.18
Queue Length 95th (ft)	1	0	8	16
Control Delay (s)	0.9	0.1	13.8	14.2
Lane LOS	A	A	B	B
Approach Delay (s)	0.9	0.1	13.8	14.2
Approach LOS			B	B

Intersection Summary			
Average Delay	2.8		
Intersection Capacity Utilization	33.6%	ICU Level of Service	A
Analysis Period (min)	15		

2: US 56 & Gardner Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	270	50	210	630	220	60	150	140	140	150	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.98			0.97		1.00	0.93		1.00	0.97	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3301			3389		1770	1694		1736	1773	
Flt Permitted		0.86			0.77		0.62	1.00		0.44	1.00	
Satd. Flow (perm)		2837			2650		1158	1694		813	1773	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	23	310	57	241	724	253	69	172	161	161	172	46
RTOR Reduction (vph)	0	22	0	0	38	0	0	60	0	0	17	0
Lane Group Flow (vph)	0	368	0	0	1180	0	69	273	0	161	201	0
Heavy Vehicles (%)	0%	8%	2%	1%	3%	1%	2%	4%	4%	4%	4%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		27.6			27.6		15.2	15.2		15.2	15.2	
Effective Green, g (s)		27.6			27.6		15.2	15.2		15.2	15.2	
Actuated g/C Ratio		0.51			0.51		0.28	0.28		0.28	0.28	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1437			1342		323	472		227	494	
v/s Ratio Prot								0.16			0.11	
v/s Ratio Perm		0.13			c0.45		0.06			c0.20		
v/c Ratio		0.26			0.88		0.21	0.58		0.71	0.41	
Uniform Delay, d1		7.6			12.0		15.1	16.9		17.7	16.0	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.1			6.9		0.3	1.7		9.7	0.5	
Delay (s)		7.7			18.9		15.4	18.6		27.4	16.5	
Level of Service		A			B		B	B		C	B	
Approach Delay (s)		7.7			18.9			18.1			21.1	
Approach LOS		A			B			B			C	

Intersection Summary			
HCM Average Control Delay	17.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	54.5	Sum of lost time (s)	11.7
Intersection Capacity Utilization	84.5%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

8: US-56 & I-35 SB Ramps

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	1320	210	100	460	0	0	0	0	120	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	0	1389	221	105	484	0	0	0	0	126	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		986										
pX, platoon unblocked				0.69			0.69	0.69	0.69	0.69	0.69	
vC, conflicting volume	484			1611			1953	2195	805	1389	2305	242
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	484			987			1483	1834	0	667	1994	242
tC, single (s)	4.1			4.2			7.5	6.5	6.9	7.5	6.5	7.0
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			77			100	100	100	36	100	100
cM capacity (veh/h)	1089			468			50	41	753	197	33	756

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	SB 1	SB 2
Volume Total	926	684	105	242	242	126	0
Volume Left	0	0	105	0	0	126	0
Volume Right	0	221	0	0	0	0	0
cSH	1700	1700	468	1700	1700	197	1700
Volume to Capacity	0.54	0.40	0.23	0.14	0.14	0.64	0.00
Queue Length 95th (ft)	0	0	21	0	0	94	0
Control Delay (s)	0.0	0.0	14.9	0.0	0.0	51.4	0.0
Lane LOS			B			F	A
Approach Delay (s)	0.0		2.7			51.4	
Approach LOS						F	

Intersection Summary			
Average Delay	3.5		
Intersection Capacity Utilization	65.4%	ICU Level of Service	C
Analysis Period (min)	15		

9: US-56 & I-35 NB Ramps

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	460	0	0	490	20	80	0	40	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	0	523	0	0	557	23	91	0	45	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	580			523			1091	1102	261	875	1091	568
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	580			523			1091	1102	261	875	1091	568
tC, single (s)	4.1			4.1			7.6	6.5	7.2	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.6	4.0	3.4	3.5	4.0	3.3
p0 queue free %	100			100			45	100	94	100	100	100
cM capacity (veh/h)	1004			1054			164	213	705	231	217	471

Direction, Lane #	EB 1	EB 2	WB 1	NB 1
Volume Total	261	261	580	136
Volume Left	0	0	0	91
Volume Right	0	0	23	45
cSH	1700	1700	1700	221
Volume to Capacity	0.15	0.15	0.34	0.62
Queue Length 95th (ft)	0	0	0	90
Control Delay (s)	0.0	0.0	0.0	44.6
Lane LOS				E
Approach Delay (s)	0.0		0.0	44.6
Approach LOS				E

Intersection Summary			
Average Delay	4.9		
Intersection Capacity Utilization	64.0%	ICU Level of Service	C
Analysis Period (min)	15		

2010 Wellsville North No Action - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study | 2010 No-Action Wellsville
11: Waverly Road & US 56 | PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	10	5	10	5	10	20	120	0	5	260	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	13	6	13	6	13	25	152	0	6	329	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	563	551	152	560	547	332	335			152		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	563	551	152	560	547	332	335			152		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.3	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.4	2.2			2.2		
p0 queue free %	100	97	99	97	99	98	98			100		
cM capacity (veh/h)	419	434	900	407	436	691	1235			1441		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	19	32	177	342
Volume Left	0	13	25	6
Volume Right	6	13	0	6
cSH	525	495	1235	1441
Volume to Capacity	0.04	0.06	0.02	0.00
Queue Length 95th (ft)	3	5	2	0
Control Delay (s)	12.1	12.8	1.3	0.2
Lane LOS	B	B	A	A
Approach Delay (s)	12.1	12.8	1.3	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	32.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2010 No-Action Wellsville
13: 183rd Street & US 56 | PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	0	10	10	0	0	140	10	0	270	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	6	0	13	13	0	0	177	13	0	342	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	532	532	342	528	525	184	342			190		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	532	532	342	528	525	184	342			190		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	99	100	97	97	100	100			100		
cM capacity (veh/h)	452	456	705	459	460	864	1229			1396		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	13	25	190	342
Volume Left	6	13	0	0
Volume Right	0	0	13	0
cSH	454	460	1229	1396
Volume to Capacity	0.03	0.06	0.00	0.00
Queue Length 95th (ft)	2	4	0	0
Control Delay (s)	13.2	13.3	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	13.2	13.3	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	24.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2010 No-Action Wellsville
16: Four Corners Road & US 56 | PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	5	0	5	5	5	150	5	5	280	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	7	7	7	0	7	7	7	197	7	7	368	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	605	595	201	605	599	368	368			204		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	605	595	201	605	599	368	368			204		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	100	98	99	99			100		
cM capacity (veh/h)	400	416	845	401	414	682	1201			1380		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	20	13	211	375
Volume Left	7	0	7	7
Volume Right	7	7	7	0
cSH	493	515	1201	1380
Volume to Capacity	0.04	0.03	0.01	0.00
Queue Length 95th (ft)	3	2	0	0
Control Delay (s)	12.6	12.2	0.3	0.2
Lane LOS	B	B	A	A
Approach Delay (s)	12.6	12.2	0.3	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	28.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2010 No-Action Wellsville
17: 191st Street & US 56 | PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	0	0	5	5	0	0	150	0	0	280	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	0	0	0	6	6	0	0	195	0	0	364	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	565	562	367	562	565	195	370			195		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	565	562	367	562	565	195	370			195		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	99	99	100	100			100		
cM capacity (veh/h)	434	439	683	441	437	852	1199			1390		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	0	13	195	370
Volume Left	0	6	0	0
Volume Right	0	0	0	6
cSH	1700	439	1199	1390
Volume to Capacity	0.00	0.03	0.00	0.00
Queue Length 95th (ft)	0	2	0	0
Control Delay (s)	0.0	13.5	0.0	0.0
Lane LOS	A	B		
Approach Delay (s)	0.0	13.5	0.0	0.0
Approach LOS	A	B		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	25.0%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Wellsville North No Action - PM Peak Hour - Synchro Intersection LOS

24: Sunflower Road & US 56

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	5	10	30	5	0	10	150	30	0	290	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	6	13	38	6	0	13	190	38	0	367	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	608	623	370	620	608	209	373			228		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	608	623	370	620	608	209	373			228		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	98	98	90	98	100	99			100		
cM capacity (veh/h)	403	400	680	383	409	837	1196			1352		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	19	44	241	373
Volume Left	0	38	13	0
Volume Right	13	0	38	6
cSH	552	387	1196	1352
Volume to Capacity	0.03	0.11	0.01	0.00
Queue Length 95th (ft)	3	10	1	0
Control Delay (s)	11.8	15.5	0.5	0.0
Lane LOS	B	C	A	
Approach Delay (s)	11.8	15.5	0.5	0.0
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	33.3%	ICU Level of Service	A
Analysis Period (min)	15		

25: US 56 & 4th Street

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	170	20	30	310	60	20
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	218	26	38	397	77	26
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			244		705	231
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			244		705	231
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		80	97
cM capacity (veh/h)			1335		391	813

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	244	436	103
Volume Left	0	38	77
Volume Right	26	0	26
cSH	1700	1335	449
Volume to Capacity	0.14	0.03	0.23
Queue Length 95th (ft)	0	2	22
Control Delay (s)	0.0	1.0	15.4
Lane LOS		A	C
Approach Delay (s)	0.0	1.0	15.4
Approach LOS			C

Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	42.7%	ICU Level of Service	A
Analysis Period (min)	15		

26: 199th Street & Four Corners Road

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	30	40	5	10	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	6	36	48	6	12	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	54				98	51
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	54				98	51
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	99
cM capacity (veh/h)	1565				902	1023

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	42	54	18
Volume Left	6	0	12
Volume Right	0	6	6
cSH	1565	1700	939
Volume to Capacity	0.00	0.03	0.02
Queue Length 95th (ft)	0	0	1
Control Delay (s)	1.1	0.0	8.9
Lane LOS	A		A
Approach Delay (s)	1.1	0.0	8.9
Approach LOS			A

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	15.8%	ICU Level of Service	A
Analysis Period (min)	15		

27: 199th Street & Gardner Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	20	20	10	30	30	10	80	10	30	170	40
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	22	22	22	11	34	34	11	90	11	34	191	45

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	67	79	112	270
Volume Left (vph)	22	11	11	34
Volume Right (vph)	22	34	11	45
Hadj (s)	-0.13	-0.18	0.01	-0.04
Departure Headway (s)	4.7	4.7	4.6	4.4
Degree Utilization, x	0.09	0.10	0.14	0.33
Capacity (veh/h)	690	701	747	792
Control Delay (s)	8.2	8.2	8.3	9.5
Approach Delay (s)	8.2	8.2	8.3	9.5
Approach LOS	A	A	A	A

Intersection Summary			
Delay	8.9		
HCM Level of Service	A		
Intersection Capacity Utilization	31.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Wellsville

28: I-35 SB Ramps & Sunflower Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	60	0	220	10	10	0	0	90	20
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	0	0	0	69	0	253	11	11	0	0	103	23
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	402	149	115	149	161	11	126			11		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	402	149	115	149	161	11	126			11		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.2			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.3			2.2		
p0 queue free %	100	100	100	92	100	76	99			100		
cM capacity (veh/h)	427	740	943	813	729	1072	1412			1621		

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	322	23	126
Volume Left	69	11	0
Volume Right	253	0	23
cSH	1004	1412	1700
Volume to Capacity	0.32	0.01	0.07
Queue Length 95th (ft)	35	1	0
Control Delay (s)	10.3	3.8	0.0
Lane LOS	B	A	
Approach Delay (s)	10.3	3.8	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	7.2		
Intersection Capacity Utilization	31.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Wellsville

29: I-35 NB Ramps & Sunflower Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	0	5	0	0	0	0	10	20	80	60	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	11	0	6	0	0	0	0	11	23	92	69	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	276	287	69	282	276	23	69			34		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	276	287	69	282	276	23	69			34		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	100	99	100	100	100	100			94		
cM capacity (veh/h)	650	589	1000	641	598	1060	1545			1564		

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	17	34	161
Volume Left	11	0	92
Volume Right	6	23	0
cSH	736	1700	1564
Volume to Capacity	0.02	0.02	0.06
Queue Length 95th (ft)	2	0	5
Control Delay (s)	10.0	0.0	4.5
Lane LOS	B		A
Approach Delay (s)	10.0	0.0	4.5
Approach LOS	B		

Intersection Summary			
Average Delay	4.2		
Intersection Capacity Utilization	24.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Wellsville

31: US 56 & Edgerton Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	110	10	40	220	10	20	5	10	20	10	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	120	11	43	239	11	22	5	11	22	11	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	250			130			478	473	125	481	473	245
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	250			130			478	473	125	481	473	245
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.2	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			97			95	99	99	95	98	99
cM capacity (veh/h)	1327			1449			476	476	931	468	476	799

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	136	293	38	38
Volume Left	5	43	22	22
Volume Right	11	11	11	5
cSH	1327	1449	553	500
Volume to Capacity	0.00	0.03	0.07	0.08
Queue Length 95th (ft)	0	2	6	6
Control Delay (s)	0.3	1.3	12.0	12.8
Lane LOS	A	A	B	B
Approach Delay (s)	0.3	1.3	12.0	12.8
Approach LOS			B	B

Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	31.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 No-Action Wellsville

32: 207th & Sunflower Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	0	40	5	5	5	90	120	5	5	80	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	0	51	6	6	6	114	152	6	6	101	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	509	503	104	551	503	155	108			158		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	509	503	104	551	503	155	108			158		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	100	95	98	99	99	92			100		
cM capacity (veh/h)	440	435	942	398	435	896	1489			1434		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	57	19	272	114
Volume Left	6	6	114	6
Volume Right	51	6	6	6
cSH	836	506	1489	1434
Volume to Capacity	0.07	0.04	0.08	0.00
Queue Length 95th (ft)	5	3	6	0
Control Delay (s)	9.6	12.4	3.6	0.5
Lane LOS	A	B	A	A
Approach Delay (s)	9.6	12.4	3.6	0.5
Approach LOS	A	B		

Intersection Summary			
Average Delay	3.9		
Intersection Capacity Utilization	28.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 33: 207th & COOP Rd
2010 No-Action Wellsville
PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	20	60	40	10	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	14	27	81	54	14	14
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	135				162	108
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	135				162	108
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				98	99
cM capacity (veh/h)	1462				814	951

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	41	135	27
Volume Left	14	0	14
Volume Right	0	54	14
cSH	1462	1700	877
Volume to Capacity	0.01	0.08	0.03
Queue Length 95th (ft)	1	0	2
Control Delay (s)	2.5	0.0	9.2
Lane LOS	A		A
Approach Delay (s)	2.5	0.0	9.2
Approach LOS			A

Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	18.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 34: 207th & Edgerton Rd
2010 No-Action Wellsville
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	10	0	5	10	50	5	5	5	20	5	5
Peak Hour Factor	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Hourly flow rate (vph)	8	15	0	8	15	76	8	8	8	30	8	8

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	23	98	23	45
Volume Left (vph)	8	8	8	30
Volume Right (vph)	0	76	8	8
Hadj (s)	0.07	-0.42	-0.13	0.03
Departure Headway (s)	4.2	3.7	4.1	4.2
Degree Utilization, x	0.03	0.10	0.03	0.05
Capacity (veh/h)	834	963	851	830
Control Delay (s)	7.3	7.1	7.2	7.4
Approach Delay (s)	7.3	7.1	7.2	7.4
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.2		
HCM Level of Service	A		
Intersection Capacity Utilization	14.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 35: 207th & Evening Star Rd
2010 No-Action Wellsville
PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	10	5	5	10	5	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	20	10	10	20	10	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			30		65	25
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			30		65	25
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		99	99
cM capacity (veh/h)			1596		940	1057

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	30	30	20
Volume Left	0	10	10
Volume Right	10	0	10
cSH	1700	1596	995
Volume to Capacity	0.02	0.01	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	2.5	8.7
Lane LOS		A	A
Approach Delay (s)	0.0	2.5	8.7
Approach LOS			A

Intersection Summary			
Average Delay	3.1		
Intersection Capacity Utilization	15.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 36: 215th & Evening Star Rd
2010 No-Action Wellsville
PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	5	5	0	5	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	10	10	0	10	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	10				20	10
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	10				20	10
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	99
cM capacity (veh/h)	1623				1002	1077

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	10	10	20
Volume Left	0	0	10
Volume Right	0	0	10
cSH	1623	1700	1038
Volume to Capacity	0.00	0.01	0.02
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	0.0	8.5
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.5
Approach LOS			A

Intersection Summary			
Average Delay	4.3		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Wellsville North No Action - (Improved) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)
1: 175th Street & Waverly Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	90	5	5	280	80	10	20	5	30	20	20
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	12	108	6	6	337	96	12	24	6	36	24	24
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	434			114			569	581	111	551	536	386
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	434			114			569	581	111	551	536	386
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			100			97	94	99	91	95	96
cM capacity (veh/h)	1137			1487			398	421	947	417	447	667

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	127	440	42	84
Volume Left	12	6	12	36
Volume Right	6	96	6	24
cSH	1137	1487	450	477
Volume to Capacity	0.01	0.00	0.09	0.18
Queue Length 95th (ft)	1	0	8	16
Control Delay (s)	0.9	0.1	13.8	14.2
Lane LOS	A	A	B	B
Approach Delay (s)	0.9	0.1	13.8	14.2
Approach LOS			B	B

Intersection Summary			
Average Delay	2.8		
Intersection Capacity Utilization	33.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)
2: US 56 & Gardner Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	270	50	210	630	220	60	150	140	140	150	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.98			0.97		1.00	0.93		1.00	0.97	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3301			3389		1770	1694		1736	1773	
Flt Permitted		0.86			0.77		0.62	1.00		0.44	1.00	
Satd. Flow (perm)		2837			2650		1158	1694		813	1773	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	23	310	57	241	724	253	69	172	161	161	172	46
RTOR Reduction (vph)	0	22	0	0	38	0	0	60	0	0	17	0
Lane Group Flow (vph)	0	368	0	0	1180	0	69	273	0	161	201	0
Heavy Vehicles (%)	0%	8%	2%	1%	3%	1%	2%	4%	4%	4%	4%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		27.6			27.6		15.2	15.2		15.2	15.2	
Effective Green, g (s)		27.6			27.6		15.2	15.2		15.2	15.2	
Actuated g/C Ratio		0.51			0.51		0.28	0.28		0.28	0.28	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1437			1342		323	472		227	494	
v/s Ratio Prot								0.16			0.11	
v/s Ratio Perm		0.13			c0.45		0.06			c0.20		
v/c Ratio		0.26			0.88		0.21	0.58		0.71	0.41	
Uniform Delay, d1		7.6			12.0		15.1	16.9		17.7	16.0	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.1			6.9		0.3	1.7		9.7	0.5	
Delay (s)		7.7			18.9		15.4	18.6		27.4	16.5	
Level of Service		A			B		B	B		C	B	
Approach Delay (s)		7.7			18.9			18.1			21.1	
Approach LOS		A			B			B			C	

Intersection Summary			
HCM Average Control Delay	17.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	54.5	Sum of lost time (s)	11.7
Intersection Capacity Utilization	84.5%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)
8: US-56 & I-35 SB Ramps — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1320	210	100	460	0	0	0	0	120	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		4.0	5.0					5.0		
Lane Util. Factor		0.95		1.00	0.95					1.00		
Frt		0.98		1.00	1.00					1.00		
Flt Protected		1.00		0.95	1.00					0.95		
Satd. Flow (prot)		3437		1719	3725					1770		
Flt Permitted		1.00		0.09	1.00					0.95		
Satd. Flow (perm)		3437		160	3725					1770		
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1389	221	105	484	0	0	0	0	126	0	0
RTOR Reduction (vph)	0	14	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	1596	0	105	484	0	0	0	0	126	0	0
Heavy Vehicles (%)	0%	3%	2%	5%	2%	0%	0%	0%	0%	2%	0%	3%
Turn Type	Prot			pm+pt						custom		custom
Protected Phases	5	2		1	6							5
Permitted Phases				6						4		4
Actuated Green, G (s)		41.2		51.1	51.1					8.9		
Effective Green, g (s)		41.2		51.1	51.1					8.9		
Actuated g/C Ratio		0.59		0.73	0.73					0.13		
Clearance Time (s)		5.0		4.0	5.0					5.0		
Vehicle Extension (s)		3.0		3.0	3.0					3.0		
Lane Grp Cap (vph)		2023		248	2719					225		
v/s Ratio Prot		c0.46		c0.04	0.13							
v/s Ratio Perm				0.27						c0.07		
v/c Ratio		0.79		0.42	0.18					0.56		
Uniform Delay, d1		11.1		8.9	2.9					28.7		
Progression Factor		0.67		0.89	1.25					1.00		
Incremental Delay, d2		2.4		1.1	0.1					3.2		
Delay (s)		9.8		9.0	3.8					31.9		
Level of Service		A		A	A					C		
Approach Delay (s)		9.8			4.7			0.0			31.9	
Approach LOS		A			A			A			C	

Intersection Summary			
HCM Average Control Delay	9.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	66.5%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)
9: US-56 & I-35 NB Ramps — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	460	0	0	490	20	80	0	40	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			0.99			0.96				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3762			1847			1622				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3762			1847			1622				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	523	0	0	557	23	91	0	45	0	0	0
RTOR Reduction (vph)	0	0	0	0	2	0	0	28	0	0	0	0
Lane Group Flow (vph)	0	523	0	0	578	0	0	108	0	0	0	0
Heavy Vehicles (%)	0%	1%	0%	0%	2%	10%	6%	0%	13%	0%	0%	0%
Turn Type							Perm					
Protected Phases		2			6			8				
Permitted Phases							8					
Actuated Green, G (s)		51.2			51.2			8.8				
Effective Green, g (s)		51.2			51.2			8.8				
Actuated g/C Ratio		0.73			0.73			0.13				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		2752			1351			204				
v/s Ratio Prot		0.14			c0.31							
v/s Ratio Perm								0.07				
v/c Ratio		0.19			0.43			0.53				
Uniform Delay, d1		2.9			3.7			28.7				
Progression Factor		1.11			1.00			1.00				
Incremental Delay, d2		0.1			1.0			2.5				
Delay (s)		3.4			4.7			31.1				
Level of Service		A			A			C				
Approach Delay (s)		3.4			4.7			31.1			0.0	
Approach LOS		A			A			C			A	

Intersection Summary			
HCM Average Control Delay	7.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

2010 Wellsville North No Action - (Improved) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)
11: Waverly Road & US 56 — PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	10	5	10	5	10	20	120	0	5	260	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	13	6	13	6	13	25	152	0	6	329	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	563	551	152	560	547	332	335			152		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	563	551	152	560	547	332	335			152		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.3	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.4	2.2			2.2		
p0 queue free %	100	97	99	97	99	98	98			100		
cM capacity (veh/h)	419	434	900	407	436	691	1235			1441		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	19	32	177	342
Volume Left	0	13	25	6
Volume Right	6	13	0	6
cSH	525	495	1235	1441
Volume to Capacity	0.04	0.06	0.02	0.00
Queue Length 95th (ft)	3	5	2	0
Control Delay (s)	12.1	12.8	1.3	0.2
Lane LOS	B	B	A	A
Approach Delay (s)	12.1	12.8	1.3	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	32.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)
13: 183rd Street & US 56 — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	0	10	10	0	0	140	10	0	270	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	6	0	13	13	0	0	177	13	0	342	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	532	532	342	528	525	184	342			190		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	532	532	342	528	525	184	342			190		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	99	100	97	97	100	100			100		
cM capacity (veh/h)	452	456	705	459	460	864	1229			1396		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	13	25	190	342
Volume Left	6	13	0	0
Volume Right	0	0	13	0
cSH	454	460	1229	1396
Volume to Capacity	0.03	0.06	0.00	0.00
Queue Length 95th (ft)	2	4	0	0
Control Delay (s)	13.2	13.3	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	13.2	13.3	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	24.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)
16: Four Corners Road & US 56 — PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	5	0	5	5	5	150	5	5	280	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	7	7	7	0	7	7	7	197	7	7	368	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	605	595	201	605	599	368	368			204		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	605	595	201	605	599	368	368			204		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	100	98	99	99			100		
cM capacity (veh/h)	400	416	845	401	414	682	1201			1380		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	20	13	211	375
Volume Left	7	0	7	7
Volume Right	7	7	7	0
cSH	493	515	1201	1380
Volume to Capacity	0.04	0.03	0.01	0.00
Queue Length 95th (ft)	3	2	0	0
Control Delay (s)	12.6	12.2	0.3	0.2
Lane LOS	B	B	A	A
Approach Delay (s)	12.6	12.2	0.3	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	28.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)
17: 191st Street & US 56 — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	0	0	5	5	0	0	150	0	0	280	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	0	0	0	6	6	0	0	195	0	0	364	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	565	562	367	562	565	195	370			195		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	565	562	367	562	565	195	370			195		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	99	99	100	100			100		
cM capacity (veh/h)	434	439	683	441	437	852	1199			1390		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	0	13	195	370
Volume Left	0	6	0	0
Volume Right	0	0	0	6
cSH	1700	439	1199	1390
Volume to Capacity	0.00	0.03	0.00	0.00
Queue Length 95th (ft)	0	2	0	0
Control Delay (s)	0.0	13.5	0.0	0.0
Lane LOS	A	B		
Approach Delay (s)	0.0	13.5	0.0	0.0
Approach LOS	A	B		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	25.0%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Wellsville North No Action - (Improved) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)

24: Sunflower Road & US 56

PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	5	10	30	5	0	10	150	30	0	290	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	6	13	38	6	0	13	190	38	0	367	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	608	623	370	620	608	209	373			228		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	608	623	370	620	608	209	373			228		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	98	98	90	98	100	99			100		
cM capacity (veh/h)	403	400	680	383	409	837	1196			1352		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	19	44	241	373
Volume Left	0	38	13	0
Volume Right	13	0	38	6
cSH	552	387	1196	1352
Volume to Capacity	0.03	0.11	0.01	0.00
Queue Length 95th (ft)	3	10	1	0
Control Delay (s)	11.8	15.5	0.5	0.0
Lane LOS	B	C	A	
Approach Delay (s)	11.8	15.5	0.5	0.0
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	33.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)

25: US 56 & 4th Street

PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	170	20	30	310	60	20
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	218	26	38	397	77	26
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			244		705	231
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			244		705	231
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		80	97
cM capacity (veh/h)			1335		391	813

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	244	436	103
Volume Left	0	38	77
Volume Right	26	0	26
cSH	1700	1335	449
Volume to Capacity	0.14	0.03	0.23
Queue Length 95th (ft)	0	2	22
Control Delay (s)	0.0	1.0	15.4
Lane LOS		A	C
Approach Delay (s)	0.0	1.0	15.4
Approach LOS			C

Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	42.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)

26: 199th Street & Four Corners Road

PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	30	40	5	10	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	6	36	48	6	12	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	54				98	51
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	54				98	51
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	99
cM capacity (veh/h)	1565				902	1023

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	42	54	18
Volume Left	6	0	12
Volume Right	0	6	6
cSH	1565	1700	939
Volume to Capacity	0.00	0.03	0.02
Queue Length 95th (ft)	0	0	1
Control Delay (s)	1.1	0.0	8.9
Lane LOS	A		A
Approach Delay (s)	1.1	0.0	8.9
Approach LOS			A

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	15.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)

27: 199th Street & Gardner Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	20	20	10	30	30	10	80	10	30	170	40
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	22	22	22	11	34	34	11	90	11	34	191	45

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	67	79	112	270
Volume Left (vph)	22	11	11	34
Volume Right (vph)	22	34	11	45
Hadj (s)	-0.13	-0.18	0.01	-0.04
Departure Headway (s)	4.7	4.7	4.6	4.4
Degree Utilization, x	0.09	0.10	0.14	0.33
Capacity (veh/h)	690	701	747	792
Control Delay (s)	8.2	8.2	8.3	9.5
Approach Delay (s)	8.2	8.2	8.3	9.5
Approach LOS	A	A	A	A

Intersection Summary			
Delay	8.9		
HCM Level of Service	A		
Intersection Capacity Utilization	31.8%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Wellsville North No Action - (Improved) - PM Peak Hour - Synchro Intersection LOS

28: I-35 SB Ramps & Sunflower Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	60	0	220	10	10	0	0	90	20
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	0	0	0	69	0	253	11	11	0	0	103	23
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	402	149	115	149	161	11	126			11		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	402	149	115	149	161	11	126			11		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.2			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.3			2.2		
p0 queue free %	100	100	100	92	100	76	99			100		
cM capacity (veh/h)	427	740	943	813	729	1072	1412			1621		

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	322	23	126
Volume Left	69	11	0
Volume Right	253	0	23
cSH	1004	1412	1700
Volume to Capacity	0.32	0.01	0.07
Queue Length 95th (ft)	35	1	0
Control Delay (s)	10.3	3.8	0.0
Lane LOS	B	A	
Approach Delay (s)	10.3	3.8	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	7.2		
Intersection Capacity Utilization	31.3%	ICU Level of Service	A
Analysis Period (min)	15		

29: I-35 NB Ramps & Sunflower Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	0	5	0	0	0	0	10	20	80	60	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	11	0	6	0	0	0	0	11	23	92	69	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	276	287	69	282	276	23	69			34		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	276	287	69	282	276	23	69			34		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	100	99	100	100	100	100			94		
cM capacity (veh/h)	650	589	1000	641	598	1060	1545			1564		

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	17	34	161
Volume Left	11	0	92
Volume Right	6	23	0
cSH	736	1700	1564
Volume to Capacity	0.02	0.02	0.06
Queue Length 95th (ft)	2	0	5
Control Delay (s)	10.0	0.0	4.5
Lane LOS	B		A
Approach Delay (s)	10.0	0.0	4.5
Approach LOS	B		

Intersection Summary			
Average Delay	4.2		
Intersection Capacity Utilization	24.3%	ICU Level of Service	A
Analysis Period (min)	15		

31: US 56 & Edgerton Rd

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	110	10	40	220	10	20	5	10	20	10	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	120	11	43	239	11	22	5	11	22	11	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	250			130			478	473	125	481	473	245
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	250			130			478	473	125	481	473	245
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.2	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			97			95	99	99	95	98	99
cM capacity (veh/h)	1327			1449			476	476	931	468	476	799

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	136	293	38	38
Volume Left	5	43	22	22
Volume Right	11	11	11	5
cSH	1327	1449	553	500
Volume to Capacity	0.00	0.03	0.07	0.08
Queue Length 95th (ft)	0	2	6	6
Control Delay (s)	0.3	1.3	12.0	12.8
Lane LOS	A	A	B	B
Approach Delay (s)	0.3	1.3	12.0	12.8
Approach LOS			B	B

Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	31.1%	ICU Level of Service	A
Analysis Period (min)	15		

32: 207th & Sunflower Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	0	40	5	5	5	90	120	5	5	80	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	0	51	6	6	6	114	152	6	6	101	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	509	503	104	551	503	155	108			158		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	509	503	104	551	503	155	108			158		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	100	95	98	99	99	92			100		
cM capacity (veh/h)	440	435	942	398	435	896	1489			1434		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	57	19	272	114
Volume Left	6	6	114	6
Volume Right	51	6	6	6
cSH	836	506	1489	1434
Volume to Capacity	0.07	0.04	0.08	0.00
Queue Length 95th (ft)	5	3	6	0
Control Delay (s)	9.6	12.4	3.6	0.5
Lane LOS	A	B	A	A
Approach Delay (s)	9.6	12.4	3.6	0.5
Approach LOS	A	B		

Intersection Summary			
Average Delay	3.9		
Intersection Capacity Utilization	28.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)

33: 207th & COOP Rd

PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	20	60	40	20	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	14	27	81	54	27	14
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	135				162	108
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	135				162	108
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				97	99
cM capacity (veh/h)	1462				814	951

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	41	135	41
Volume Left	14	0	27
Volume Right	0	54	14
cSH	1462	1700	855
Volume to Capacity	0.01	0.08	0.05
Queue Length 95th (ft)	1	0	4
Control Delay (s)	2.5	0.0	9.4
Lane LOS	A		A
Approach Delay (s)	2.5	0.0	9.4
Approach LOS			A

Intersection Summary			
Average Delay	2.2		
Intersection Capacity Utilization	18.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)

34: 207th & Edgerton Rd

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	10	0	5	10	50	5	5	5	20	5	5
Peak Hour Factor	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Hourly flow rate (vph)	8	15	0	8	15	76	8	8	8	30	8	8

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	23	98	23	45
Volume Left (vph)	8	8	8	30
Volume Right (vph)	0	76	8	8
Hadj (s)	0.07	-0.42	-0.13	0.03
Departure Headway (s)	4.2	3.7	4.1	4.2
Degree Utilization, x	0.03	0.10	0.03	0.05
Capacity (veh/h)	834	963	851	830
Control Delay (s)	7.3	7.1	7.2	7.4
Approach Delay (s)	7.3	7.1	7.2	7.4
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.2		
HCM Level of Service	A		
Intersection Capacity Utilization	14.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)

35: 207th & Evening Star Rd

PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	10	5	5	10	5	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	20	10	10	20	10	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			30		65	25
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			30		65	25
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		99	99
cM capacity (veh/h)			1596		940	1057

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	30	30	20
Volume Left	0	10	10
Volume Right	10	0	10
cSH	1700	1596	995
Volume to Capacity	0.02	0.01	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	2.5	8.7
Lane LOS		A	A
Approach Delay (s)	0.0	2.5	8.7
Approach LOS			A

Intersection Summary			
Average Delay	3.1		
Intersection Capacity Utilization	15.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville No-Action - (Improved)

36: 215th & Evening Star Rd

PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	5	5	0	5	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	10	10	0	10	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	10				20	10
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	10				20	10
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	99
cM capacity (veh/h)	1623				1002	1077

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	10	10	20
Volume Left	0	0	10
Volume Right	0	0	10
cSH	1623	1700	1038
Volume to Capacity	0.00	0.01	0.02
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	0.0	8.5
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.5
Approach LOS			A

Intersection Summary			
Average Delay	4.3		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Wellsville North Alternative - AM Peak Hour

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action
1: 175th Street & Waverly Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	60	290	5	0	50	50	5	80	5	90	30	10
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	72	349	6	0	60	60	6	96	6	108	36	12
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	120			355			617	617	352	642	590	90
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	120			355			617	617	352	642	590	90
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.3
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.4
p0 queue free %	95			100			98	75	99	63	91	99
cM capacity (veh/h)	1449			1214			358	384	696	296	398	946

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	428	120	108	157
Volume Left	72	0	6	108
Volume Right	6	60	6	12
cSH	1449	1214	392	333
Volume to Capacity	0.05	0.00	0.28	0.47
Queue Length 95th (ft)	4	0	28	60
Control Delay (s)	1.7	0.0	17.7	25.0
Lane LOS	A		C	D
Approach Delay (s)	1.7	0.0	17.7	25.0
Approach LOS			C	D

Intersection Summary			
Average Delay	8.1		
Intersection Capacity Utilization	46.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action
2: US 56 & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	560	60	100	210	100	70	320	190	140	200	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.99			0.96		1.00	0.94		1.00	0.98	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3363			3173		1805	1725		1736	1794	
Flt Permitted		0.90			0.62		0.60	1.00		0.25	1.00	
Satd. Flow (perm)		3019			1996		1133	1725		454	1794	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	46	644	69	115	241	115	80	368	218	161	230	34
RTOR Reduction (vph)	0	15	0	0	64	0	0	31	0	0	8	0
Lane Group Flow (vph)	0	744	0	0	407	0	80	555	0	161	256	0
Heavy Vehicles (%)	5%	6%	2%	7%	10%	6%	0%	4%	4%	4%	4%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		18.0			18.0		19.4	19.4		19.4	19.4	
Effective Green, g (s)		18.0			18.0		19.4	19.4		19.4	19.4	
Actuated g/C Ratio		0.37			0.37		0.40	0.40		0.40	0.40	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1107			732		448	682		179	709	
v/s Ratio Prot								0.32			0.14	
v/s Ratio Perm		c0.25			0.20		0.07			c0.35		
v/c Ratio		0.67			0.56		0.18	0.81		0.90	0.36	
Uniform Delay, d1		13.1			12.4		9.7	13.2		13.9	10.5	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.6			0.9		0.2	7.4		39.5	0.3	
Delay (s)		14.7			13.3		9.9	20.6		53.5	10.8	
Level of Service		B			B		A	C		D	B	
Approach Delay (s)		14.7			13.3			19.3			27.0	
Approach LOS		B			B			B			C	

Intersection Summary			
HCM Average Control Delay	18.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	49.1	Sum of lost time (s)	11.7
Intersection Capacity Utilization	86.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action
8: US-56 & I-35 SB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1710	40	30	470	0	0	0	0	50	0	920
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					2.5		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		1.00		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3511		1641	3689					1641		2760
Flt Permitted		1.00		0.95	1.00					0.95		1.00
Satd. Flow (perm)		3511		1641	3689					1641		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1800	42	32	495	0	0	0	0	53	0	968
RTOR Reduction (vph)	0	1	0	0	0	0	0	0	0	0	0	301
Lane Group Flow (vph)	0	1841	0	32	495	0	0	0	0	53	0	667
Heavy Vehicles (%)	0%	2%	23%	10%	3%	0%	0%	0%	0%	10%	0%	3%
Turn Type				Prot						Prot		custom
Protected Phases		2		1	6					7		5
Permitted Phases												4
Actuated Green, G (s)		67.8		4.2	42.0					5.5		30.0
Effective Green, g (s)		67.8		4.2	42.0					5.5		30.0
Actuated g/C Ratio		0.75		0.05	0.47					0.06		0.33
Clearance Time (s)		5.0		5.0	5.0					2.5		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2645		77	1722					100		920
v/s Ratio Prot		c0.52		0.02	c0.13					c0.03		0.24
v/s Ratio Perm												
v/c Ratio		0.70		0.42	0.29					0.53		0.73
Uniform Delay, d1		5.8		41.7	14.8					41.0		26.4
Progression Factor		0.59		1.07	0.82					1.00		1.00
Incremental Delay, d2		1.0		3.3	0.4					5.3		2.9
Delay (s)		4.4		47.8	12.5					46.3		29.2
Level of Service		A		D	B					D		C
Approach Delay (s)		4.4			14.7			0.0			30.1	
Approach LOS		A			B			A			C	

Intersection Summary			
HCM Average Control Delay	13.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.5
Intersection Capacity Utilization	59.4%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action
9: US-56 & I-35 NB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	350	0	0	350	130	150	0	90	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			0.96			0.95				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3725			1795			1616				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3725			1795			1616				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	398	0	0	398	148	170	0	102	0	0	0
RTOR Reduction (vph)	0	0	0	0	11	0	0	28	0	0	0	0
Lane Group Flow (vph)	0	398	0	0	535	0	0	244	0	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	2%	9%	0%	7%	0%	0%	0%
Turn Type							Perm					
Protected Phases		2			6			8				
Permitted Phases							8					
Actuated Green, G (s)		61.2			61.2			18.8				
Effective Green, g (s)		61.2			61.2			18.8				
Actuated g/C Ratio		0.68			0.68			0.21				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		2533			1221			338				
v/s Ratio Prot		0.11			c0.30							
v/s Ratio Perm								0.15				
v/c Ratio		0.16			0.44			0.72				
Uniform Delay, d1		5.2			6.6			33.2				
Progression Factor		0.59			1.00			1.00				
Incremental Delay, d2		0.1			1.1			7.4				
Delay (s)		3.1			7.7			40.5				
Level of Service		A			A			D				
Approach Delay (s)		3.1			7.7			40.5			0.0	
Approach LOS		A			A			D			A	

Intersection Summary			
HCM Average Control Delay	13.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	91.3%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

2010 Wellsville North Alternative - AM Peak Hour

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action
11: Waverly Road & US 56 — AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	20	0	10	5	10	60	260	0	5	90	10
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	25	0	13	6	13	76	329	0	6	114	13
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	630	620	329	627	614	120	127			329		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	630	620	329	627	614	120	127			329		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.3	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.4	2.2			2.2		
p0 queue free %	100	93	100	97	98	99	95			99		
cM capacity (veh/h)	370	383	717	363	386	910	1453			1242		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	25	32	405	133
Volume Left	0	13	76	6
Volume Right	0	13	0	13
cSH	383	485	1453	1242
Volume to Capacity	0.07	0.07	0.05	0.01
Queue Length 95th (ft)	5	5	4	0
Control Delay (s)	15.1	12.9	1.8	0.4
Lane LOS	C	B	A	A
Approach Delay (s)	15.1	12.9	1.8	0.4
Approach LOS	C	B		

Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	38.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action
13: 183rd Street & US 56 — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	10	0	10	10	5	0	320	10	0	90	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	13	0	13	13	6	0	405	13	0	114	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	541	535	117	535	532	411	120			418		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	541	535	117	535	532	411	120			418		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	97	100	97	97	99	100			100		
cM capacity (veh/h)	441	455	940	450	456	645	1480			1152		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	19	32	418	120
Volume Left	6	13	0	0
Volume Right	0	6	13	6
cSH	450	482	1480	1152
Volume to Capacity	0.04	0.07	0.00	0.00
Queue Length 95th (ft)	3	5	0	0
Control Delay (s)	13.4	13.0	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	13.4	13.0	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	27.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action
16: Four Corners Road & US 56 — AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	10	0	5	5	10	330	0	5	100	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	7	7	13	0	7	7	13	434	0	7	132	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	615	605	434	622	605	132	132			434		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	615	605	434	622	605	132	132			434		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	98	100	98	99	99			99		
cM capacity (veh/h)	394	408	626	385	408	923	1466			1136		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	26	13	447	138
Volume Left	7	0	13	7
Volume Right	13	7	0	0
cSH	489	566	1466	1136
Volume to Capacity	0.05	0.02	0.01	0.01
Queue Length 95th (ft)	4	2	1	0
Control Delay (s)	12.8	11.5	0.3	0.4
Lane LOS	B	B	A	A
Approach Delay (s)	12.8	11.5	0.3	0.4
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	33.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action
17: 191st Street & US 56 — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	5	5	0	5	0	330	5	0	100	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	6	6	6	6	0	6	0	429	6	0	130	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	571	568	133	575	568	432	136			435		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	571	568	133	575	568	432	136			435		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	99	99	98	100	99	100			100		
cM capacity (veh/h)	430	435	921	424	435	628	1460			1135		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	19	13	435	136
Volume Left	6	6	0	0
Volume Right	6	6	6	6
cSH	525	506	1460	1135
Volume to Capacity	0.04	0.03	0.00	0.00
Queue Length 95th (ft)	3	2	0	0
Control Delay (s)	12.1	12.3	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	12.1	12.3	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.7		
Intersection Capacity Utilization	27.7%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Wellsville North Alternative - AM Peak Hour

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action
24: Sunflower Road & US 56
AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	5	30	0	0	5	340	60	5	100	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	6	6	38	0	0	6	430	76	6	127	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	620	658	127	630	620	468	127			506		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	620	658	127	630	620	468	127			506		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	90	100	100	100			99		
cM capacity (veh/h)	400	383	929	377	402	599	1472			1069		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	19	38	513	133
Volume Left	6	38	6	6
Volume Right	6	0	76	0
cSH	485	377	1472	1069
Volume to Capacity	0.04	0.10	0.00	0.01
Queue Length 95th (ft)	3	8	0	0
Control Delay (s)	12.7	15.6	0.1	0.5
Lane LOS	B	C	A	A
Approach Delay (s)	12.7	15.6	0.1	0.5
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	34.1%	ICU Level of Service	A
Analysis Period (min)	15		

HDR Engineering, Inc. 4/30/2008

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action
25: US 56 & 4th Street
AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	370	50	10	130	10	30
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	474	64	13	167	13	38
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			538		699	506
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			538		699	506
tC, single (s)			4.2		6.5	6.2
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.3
p0 queue free %			99		97	93
cM capacity (veh/h)			991		389	564

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	538	179	51
Volume Left	0	13	13
Volume Right	64	0	38
cSH	1700	991	507
Volume to Capacity	0.32	0.01	0.10
Queue Length 95th (ft)	0	1	8
Control Delay (s)	0.0	0.7	12.9
Lane LOS		A	B
Approach Delay (s)	0.0	0.7	12.9
Approach LOS			B

Intersection Summary			
Average Delay	1.0		
Intersection Capacity Utilization	32.5%	ICU Level of Service	A
Analysis Period (min)	15		

HDR Engineering, Inc. 4/30/2008

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action
28: I-35 SB Ramps & Sunflower Road
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	10	0	130	5	20	0	0	360	10
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	0	0	0	11	0	149	6	23	0	0	414	11
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	603	454	420	454	460	23	425			23		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	603	454	420	454	460	23	425			23		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.6	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.7	2.2			2.2		
p0 queue free %	100	100	100	98	100	84	99			100		
cM capacity (veh/h)	348	502	638	501	499	956	1145			1605		

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	161	29	425
Volume Left	11	6	0
Volume Right	149	0	11
cSH	898	1145	1700
Volume to Capacity	0.18	0.01	0.25
Queue Length 95th (ft)	16	0	0
Control Delay (s)	9.9	1.7	0.0
Lane LOS	A	A	
Approach Delay (s)	9.9	1.7	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	34.8%	ICU Level of Service	A
Analysis Period (min)	15		

HDR Engineering, Inc. 4/30/2008

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action
29: I-35 NB Ramps & Sunflower Road
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	20	0	5	0	0	0	0	10	40	350	10	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	23	0	6	0	0	0	0	11	46	402	11	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	851	874	11	856	851	34	11			57		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	851	874	11	856	851	34	11			57		
tC, single (s)	7.2	6.5	6.2	7.1	6.5	6.2	4.1			4.3		
tC, 2 stage (s)												
tF (s)	3.6	4.0	3.3	3.5	4.0	3.3	2.2			2.4		
p0 queue free %	89	100	99	100	100	100	100			72		
cM capacity (veh/h)	208	209	1075	218	215	1044	1621			1428		

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	29	57	414
Volume Left	23	0	402
Volume Right	6	46	0
cSH	248	1700	1428
Volume to Capacity	0.12	0.03	0.28
Queue Length 95th (ft)	10	0	29
Control Delay (s)	21.4	0.0	8.3
Lane LOS	C		A
Approach Delay (s)	21.4	0.0	8.3
Approach LOS	C		

Intersection Summary			
Average Delay	8.1		
Intersection Capacity Utilization	36.6%	ICU Level of Service	A
Analysis Period (min)	15		

HDR Engineering, Inc. 4/30/2008

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action
31: US 56 & Edgerton Rd
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✥			✥			✥			✥	
Volume (veh/h)	5	260	20	40	70	5	10	10	70	20	10	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	283	22	43	76	5	11	11	76	22	11	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	82			304			476	473	293	552	481	79
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	82			304			476	473	293	552	481	79
tC, single (s)	4.1			4.2			7.4	6.8	6.3	7.1	6.6	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.3			3.8	4.3	3.4	3.5	4.1	3.3
p0 queue free %	100			96			97	97	90	94	98	100
cM capacity (veh/h)	1529			1196			434	433	734	382	454	987

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	310	125	98	33
Volume Left	5	43	11	22
Volume Right	22	5	76	0
cSH	1529	1196	636	403
Volume to Capacity	0.00	0.04	0.15	0.08
Queue Length 95th (ft)	0	3	14	7
Control Delay (s)	0.2	3.0	11.7	14.7
Lane LOS	A	A	B	B
Approach Delay (s)	0.2	3.0	11.7	14.7
Approach LOS			B	B

Intersection Summary			
Average Delay	3.6		
Intersection Capacity Utilization	37.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action
32: 207th & Sunflower Road
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✥			✥			✥			✥	
Volume (veh/h)	0	0	230	5	0	5	120	50	0	5	120	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	0	291	6	0	6	152	63	0	6	152	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	538	532	152	823	532	63	152			63		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	538	532	152	823	532	63	152			63		
tC, single (s)	7.1	6.5	6.5	7.1	6.5	6.2	4.5			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.6	3.5	4.0	3.3	2.6			2.2		
p0 queue free %	100	100	64	96	100	99	87			100		
cM capacity (veh/h)	409	397	819	171	397	1007	1209			1552		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	291	13	215	158
Volume Left	0	6	152	6
Volume Right	291	6	0	0
cSH	819	293	1209	1552
Volume to Capacity	0.36	0.04	0.13	0.00
Queue Length 95th (ft)	40	3	11	0
Control Delay (s)	11.8	17.9	6.3	0.3
Lane LOS	B	C	A	A
Approach Delay (s)	11.8	17.9	6.3	0.3
Approach LOS	B	C		

Intersection Summary			
Average Delay	7.5		
Intersection Capacity Utilization	36.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action
33: 207th & COOP Rd
AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↰↑	↑↱		↰↱	
Volume (veh/h)	10	190	110	10	40	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	14	257	149	14	54	14
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	162				439	155
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	162				439	155
tC, single (s)	4.1				6.4	6.4
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.5
p0 queue free %	99				91	98
cM capacity (veh/h)	1429				573	845

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	270	162	68
Volume Left	14	0	54
Volume Right	0	14	14
cSH	1429	1700	613
Volume to Capacity	0.01	0.10	0.11
Queue Length 95th (ft)	1	0	9
Control Delay (s)	0.5	0.0	11.6
Lane LOS	A		B
Approach Delay (s)	0.5	0.0	11.6
Approach LOS			B

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	27.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action
34: 207th & Edgerton Rd
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✥			✥			✥			✥	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	30	130	0	0	100	10	0	5	0	70	5	20
Peak Hour Factor	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Hourly flow rate (vph)	45	197	0	0	152	15	0	8	0	106	8	30

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	242	167	8	144
Volume Left (vph)	45	0	0	106
Volume Right (vph)	0	15	0	30
Hadj (s)	0.91	0.80	0.34	0.12
Departure Headway (s)	5.5	5.5	5.6	5.2
Degree Utilization, x	0.37	0.25	0.01	0.21
Capacity (veh/h)	633	632	577	644
Control Delay (s)	11.6	10.3	8.7	9.5
Approach Delay (s)	11.6	10.3	8.7	9.5
Approach LOS	B	B	A	A

Intersection Summary			
Delay	10.6		
HCM Level of Service	B		
Intersection Capacity Utilization	33.9%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Wellsville North Alternative - AM Peak Hour

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action
35: 207th & Evening Star Rd — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	5	0	120	5	0	150
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	10	0	240	10	0	300
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			10		500	10
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			10		500	10
tC, single (s)			4.6		6.4	6.8
tC, 2 stage (s)						
tF (s)			2.6		3.5	3.8
p0 queue free %			82		100	68
cM capacity (veh/h)			1360		440	936

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	10	250	300
Volume Left	0	240	0
Volume Right	0	0	300
cSH	1700	1360	936
Volume to Capacity	0.01	0.18	0.32
Queue Length 95th (ft)	0	16	35
Control Delay (s)	0.0	7.9	10.7
Lane LOS		A	B
Approach Delay (s)	0.0	7.9	10.7
Approach LOS			B

Intersection Summary			
Average Delay	9.3		
Intersection Capacity Utilization	29.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action
36: 215th & Evening Star Rd — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	5	5	150	120	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	10	10	300	240	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	310				170	160
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	310				170	160
tC, single (s)	4.1				6.9	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.9	3.3
p0 queue free %	100				67	99
cM capacity (veh/h)	1262				727	890

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	10	310	250
Volume Left	0	0	240
Volume Right	0	300	10
cSH	1262	1700	732
Volume to Capacity	0.00	0.18	0.34
Queue Length 95th (ft)	0	0	38
Control Delay (s)	0.0	0.0	12.4
Lane LOS			B
Approach Delay (s)	0.0	0.0	12.4
Approach LOS			B

Intersection Summary			
Average Delay	5.5		
Intersection Capacity Utilization	23.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2010 Wellsville Alternative Action - (Improved)
1: 175th Street & Waverly Road | PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	90	5	5	280	80	10	20	5	30	20	20
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	12	108	6	6	337	96	12	24	6	36	24	24
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	434			114			569	581	111	551	536	386
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	434			114			569	581	111	551	536	386
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			100			97	94	99	91	95	96
cM capacity (veh/h)	1137			1487			398	421	947	417	447	667

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	127	440	42	84
Volume Left	12	6	12	36
Volume Right	6	96	6	24
cSH	1137	1487	450	477
Volume to Capacity	0.01	0.00	0.09	0.18
Queue Length 95th (ft)	1	0	8	16
Control Delay (s)	0.9	0.1	13.8	14.2
Lane LOS	A	A	B	B
Approach Delay (s)	0.9	0.1	13.8	14.2
Approach LOS			B	B

Intersection Summary			
Average Delay	2.8		
Intersection Capacity Utilization	33.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2010 Wellsville Alternative Action - (Improved)
2: US 56 & Gardner Road | PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	270	50	210	630	220	60	150	140	140	150	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.98			0.97		1.00	0.93		1.00	0.97	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3292			3369		1770	1694		1736	1766	
Flt Permitted		0.86			0.77		0.62	1.00		0.44	1.00	
Satd. Flow (perm)		2830			2634		1158	1694		808	1766	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	23	310	57	241	724	253	69	172	161	161	172	46
RTOR Reduction (vph)	0	22	0	0	37	0	0	60	0	0	17	0
Lane Group Flow (vph)	0	368	0	0	1181	0	69	273	0	161	201	0
Heavy Vehicles (%)	5%	8%	2%	1%	4%	1%	2%	4%	4%	4%	4%	5%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		27.9			27.9		15.2	15.2		15.2	15.2	
Effective Green, g (s)		27.9			27.9		15.2	15.2		15.2	15.2	
Actuated g/C Ratio		0.51			0.51		0.28	0.28		0.28	0.28	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1441			1341		321	470		224	490	
v/s Ratio Prot								0.16			0.11	
v/s Ratio Perm		0.13			c0.45		0.06			c0.20		
v/c Ratio		0.26			0.88		0.21	0.58		0.72	0.41	
Uniform Delay, d1		7.6			12.0		15.2	17.1		17.9	16.1	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.1			7.1		0.3	1.8		10.5	0.6	
Delay (s)		7.7			19.0		15.6	18.9		28.4	16.7	
Level of Service		A			B		B	B		C	B	
Approach Delay (s)		7.7			19.0			18.3			21.7	
Approach LOS		A			B			B			C	

Intersection Summary			
HCM Average Control Delay	17.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	54.8	Sum of lost time (s)	11.7
Intersection Capacity Utilization	84.5%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study | 2010 Wellsville Alternative Action - (Improved)
8: US-56 & I-35 SB Ramps | PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1320	210	100	460	0	0	0	0	120	0	1200
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					2.5		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		0.98		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3433		1687	3689					1770		2760
Flt Permitted		1.00		0.95	1.00					0.95		1.00
Satd. Flow (perm)		3433		1687	3689					1770		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1389	221	105	484	0	0	0	0	126	0	1263
RTOR Reduction (vph)	0	14	0	0	0	0	0	0	0	0	0	320
Lane Group Flow (vph)	0	1596	0	105	484	0	0	0	0	126	0	943
Heavy Vehicles (%)	0%	3%	3%	7%	3%	0%	0%	0%	0%	2%	0%	3%
Turn Type				Prot						Prot		custom
Protected Phases		2		1	6					7		5
Permitted Phases												4
Actuated Green, G (s)		61.3		7.1	40.4					9.1		28.0
Effective Green, g (s)		61.3		7.1	40.4					9.1		28.0
Actuated g/C Ratio		0.68		0.08	0.45					0.10		0.31
Clearance Time (s)		5.0		5.0	5.0					2.5		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2338		133	1656					179		859
v/s Ratio Prot		c0.46		c0.06	0.13					c0.07		c0.34
v/s Ratio Perm												
v/c Ratio		0.68		0.79	0.29					0.70		1.10
Uniform Delay, d1		8.6		40.7	15.7					39.1		31.0
Progression Factor		0.62		0.92	0.84					1.00		1.00
Incremental Delay, d2		1.1		24.6	0.4					11.9		60.8
Delay (s)		6.4		62.0	13.7					51.0		91.8
Level of Service		A		E	B					D		F
Approach Delay (s)		6.4			22.3			0.0			88.1	
Approach LOS		A			C			A			F	

Intersection Summary			
HCM Average Control Delay	40.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	17.5
Intersection Capacity Utilization	67.3%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study | 2010 Wellsville Alternative Action - (Improved)
9: US-56 & I-35 NB Ramps | PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	460	0	0	490	20	80	0	40	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			0.99			0.96				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3762			1830			1578				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3762			1830			1578				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	523	0	0	557	23	91	0	45	0	0	0
RTOR Reduction (vph)	0	0	0	0	1	0	0	26	0	0	0	0
Lane Group Flow (vph)	0	523	0	0	579	0	0	110	0	0	0	0
Heavy Vehicles (%)	0%	1%	0%	0%	3%	10%	8%	0%	18%	0%	0%	0%
Turn Type							Perm					
Protected Phases		2			6			8				
Permitted Phases							8					
Actuated Green, G (s)		68.3			68.3			11.7				
Effective Green, g (s)		68.3			68.3			11.7				
Actuated g/C Ratio		0.76			0.76			0.13				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		2855			1389			205				
v/s Ratio Prot		0.14			c0.32							
v/s Ratio Perm								0.07				
v/c Ratio		0.18			0.42			0.54				
Uniform Delay, d1		3.0			3.8			36.6				
Progression Factor		0.33			1.00			1.00				
Incremental Delay, d2		0.1			0.9			2.7				
Delay (s)		1.1			4.7			39.3				
Level of Service		A			A			D				
Approach Delay (s)		1.1			4.7			39.3			0.0	
Approach LOS		A			A			D			A	

Intersection Summary			
HCM Average Control Delay	7.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

2010 Wellsville North Alternative - PM Peak Hour

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action - (Improved)

11: Waverly Road & US 56

PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	10	5	10	5	10	20	120	0	5	270	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	13	6	13	6	13	25	152	0	6	342	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	576	563	152	573	560	345	348			152		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	576	563	152	573	560	345	348			152		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.3	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.4	2.2			2.2		
p0 queue free %	100	97	99	97	99	98	98			100		
cM capacity (veh/h)	411	427	900	399	429	680	1222			1441		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	19	32	177	354
Volume Left	0	13	25	6
Volume Right	6	13	0	6
cSH	518	486	1222	1441
Volume to Capacity	0.04	0.07	0.02	0.00
Queue Length 95th (ft)	3	5	2	0
Control Delay (s)	12.2	12.9	1.3	0.2
Lane LOS	B	B	A	A
Approach Delay (s)	12.2	12.9	1.3	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	32.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action - (Improved)

13: 183rd Street & US 56

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	0	5	10	0	0	150	10	0	270	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	6	0	6	13	0	0	190	13	0	342	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	544	544	342	541	538	196	342			203		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	544	544	342	541	538	196	342			203		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	99	100	99	97	100	100			100		
cM capacity (veh/h)	443	449	705	450	453	850	1229			1381		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	13	19	203	342
Volume Left	6	6	0	0
Volume Right	0	0	13	0
cSH	446	452	1229	1381
Volume to Capacity	0.03	0.04	0.00	0.00
Queue Length 95th (ft)	2	3	0	0
Control Delay (s)	13.3	13.3	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	13.3	13.3	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.7		
Intersection Capacity Utilization	24.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action - (Improved)

16: Four Corners Road & US 56

PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	5	0	5	5	5	160	5	5	280	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	7	7	7	0	7	7	7	211	7	7	368	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	618	609	214	618	612	368	368			217		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	618	609	214	618	612	368	368			217		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	100	98	99	99			100		
cM capacity (veh/h)	392	408	831	393	407	682	1201			1365		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	20	13	224	375
Volume Left	7	0	7	7
Volume Right	7	7	7	0
cSH	484	509	1201	1365
Volume to Capacity	0.04	0.03	0.01	0.00
Queue Length 95th (ft)	3	2	0	0
Control Delay (s)	12.8	12.3	0.3	0.2
Lane LOS	B	B	A	A
Approach Delay (s)	12.8	12.3	0.3	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	28.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action - (Improved)

17: 191st Street & US 56

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	0	0	5	5	0	0	150	0	0	290	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	0	0	0	6	6	0	0	195	0	0	377	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	578	575	380	575	578	195	383			195		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	578	575	380	575	578	195	383			195		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	98	98	100	100			100		
cM capacity (veh/h)	425	431	672	432	430	852	1186			1390		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	0	13	195	383
Volume Left	0	6	0	0
Volume Right	0	0	0	6
cSH	1700	431	1186	1390
Volume to Capacity	0.00	0.03	0.00	0.00
Queue Length 95th (ft)	0	2	0	0
Control Delay (s)	0.0	13.6	0.0	0.0
Lane LOS	A	B		
Approach Delay (s)	0.0	13.6	0.0	0.0
Approach LOS	A	B		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	25.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2010 Wellsville Alternative Action - (Improved)
24: Sunflower Road & US 56 | PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	5	10	30	5	0	10	150	40	0	300	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	6	13	38	6	0	13	190	51	0	380	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	627	649	383	639	627	215	386			241		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	627	649	383	639	627	215	386			241		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	100	98	98	90	98	100	99			100		
cM capacity (veh/h)	391	387	669	363	399	830	1183			1338		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	19	44	253	386
Volume Left	0	38	13	0
Volume Right	13	0	51	6
cSH	538	368	1183	1338
Volume to Capacity	0.04	0.12	0.01	0.00
Queue Length 95th (ft)	3	10	1	0
Control Delay (s)	11.9	16.1	0.5	0.0
Lane LOS	B	C	A	
Approach Delay (s)	11.9	16.1	0.5	0.0
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	34.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2010 Wellsville Alternative Action - (Improved)
25: US 56 & 4th Street | PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	170	20	30	320	60	20
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	218	26	38	410	77	26
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			244		718	231
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			244		718	231
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		80	97
cM capacity (veh/h)			1335		384	813

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	244	449	103
Volume Left	0	38	77
Volume Right	26	0	26
cSH	1700	1335	443
Volume to Capacity	0.14	0.03	0.23
Queue Length 95th (ft)	0	2	22
Control Delay (s)	0.0	0.9	15.6
Lane LOS		A	C
Approach Delay (s)	0.0	0.9	15.6
Approach LOS			C

Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	43.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2010 Wellsville Alternative Action - (Improved)
28: I-35 SB Ramps & Sunflower Road | PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	60	0	310	5	10	0	0	160	30
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	0	0	0	69	0	356	6	11	0	0	184	34
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	580	224	201	224	241	11	218			11		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	580	224	201	224	241	11	218			11		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.5	4.3			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.6	2.4			2.2		
p0 queue free %	100	100	100	91	100	64	100			100		
cM capacity (veh/h)	274	675	845	729	661	996	1251			1621		

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	425	17	218
Volume Left	69	6	0
Volume Right	356	0	34
cSH	940	1251	1700
Volume to Capacity	0.45	0.00	0.13
Queue Length 95th (ft)	60	0	0
Control Delay (s)	12.0	2.7	0.0
Lane LOS	B	A	
Approach Delay (s)	12.0	2.7	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	7.8		
Intersection Capacity Utilization	39.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2010 Wellsville Alternative Action - (Improved)
29: I-35 NB Ramps & Sunflower Road | PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	0	5	0	0	0	0	10	20	160	60	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	11	0	6	0	0	0	0	11	23	184	69	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	460	471	69	466	460	23	69			34		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	460	471	69	466	460	23	69			34		
tC, single (s)	7.4	6.5	6.2	7.1	6.5	6.2	4.1			4.6		
tC, 2 stage (s)												
tF (s)	3.8	4.0	3.3	3.5	4.0	3.3	2.2			2.6		
p0 queue free %	97	100	99	100	100	100	100			86		
cM capacity (veh/h)	418	426	1000	454	432	1060	1545			1340		

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	17	34	253
Volume Left	11	0	184
Volume Right	6	23	0
cSH	519	1700	1340
Volume to Capacity	0.03	0.02	0.14
Queue Length 95th (ft)	3	0	12
Control Delay (s)	12.2	0.0	6.2
Lane LOS	B		A
Approach Delay (s)	12.2	0.0	6.2
Approach LOS	B		

Intersection Summary			
Average Delay	5.9		
Intersection Capacity Utilization	28.7%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Wellsville North Alternative - PM Peak Hour

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action - (Improved)

31: US 56 & Edgerton Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	110	10	40	220	10	20	5	20	20	10	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	120	11	43	239	11	22	5	22	22	11	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	250			130			478	473	125	492	473	245
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	250			130			478	473	125	492	473	245
tC, single (s)	4.1			4.2			7.2	6.7	6.4	7.2	6.6	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.3			3.6	4.2	3.5	3.5	4.1	3.3
p0 queue free %	100			97			95	99	98	95	98	99
cM capacity (veh/h)	1327			1378			460	448	879	453	461	799

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	136	293	49	38
Volume Left	5	43	22	22
Volume Right	11	11	22	5
cSH	1327	1378	581	486
Volume to Capacity	0.00	0.03	0.08	0.08
Queue Length 95th (ft)	0	2	7	6
Control Delay (s)	0.3	1.4	11.8	13.0
Lane LOS	A	A	B	B
Approach Delay (s)	0.3	1.4	11.8	13.0
Approach LOS			B	B

Intersection Summary			
Average Delay	3.0		
Intersection Capacity Utilization	31.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action - (Improved)

32: 207th & Sunflower Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	0	110	5	5	5	180	120	5	5	80	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	0	139	6	6	6	228	152	6	6	101	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	737	731	104	867	731	155	108			158		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	737	731	104	867	731	155	108			158		
tC, single (s)	7.1	6.5	6.9	7.1	6.5	6.2	4.6			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.9	3.5	4.0	3.3	2.7			2.2		
p0 queue free %	98	100	83	97	98	99	81			100		
cM capacity (veh/h)	281	285	801	194	285	896	1227			1434		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	146	19	386	114
Volume Left	6	6	228	6
Volume Right	139	6	6	6
cSH	742	307	1227	1434
Volume to Capacity	0.20	0.06	0.19	0.00
Queue Length 95th (ft)	18	5	17	0
Control Delay (s)	11.0	17.5	5.8	0.5
Lane LOS	B	C	A	A
Approach Delay (s)	11.0	17.5	5.8	0.5
Approach LOS	B	C		

Intersection Summary			
Average Delay	6.4		
Intersection Capacity Utilization	37.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action - (Improved)

33: 207th & COOP Rd — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	100	150	40	20	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	14	135	203	54	27	7
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	257				392	230
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	257				392	230
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				95	99
cM capacity (veh/h)	1320				600	814

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	149	257	34
Volume Left	14	0	27
Volume Right	0	54	7
cSH	1320	1700	634
Volume to Capacity	0.01	0.15	0.05
Queue Length 95th (ft)	1	0	4
Control Delay (s)	0.8	0.0	11.0
Lane LOS	A		B
Approach Delay (s)	0.8	0.0	11.0
Approach LOS			B

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	23.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action - (Improved)

34: 207th & Edgerton Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	80	0	5	100	50	5	5	5	20	5	10
Peak Hour Factor	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Hourly flow rate (vph)	15	121	0	8	152	76	8	8	8	30	8	15

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	136	235	23	53
Volume Left (vph)	15	8	8	30
Volume Right (vph)	0	76	8	15
Hadj (s)	1.48	0.81	-0.13	0.33
Departure Headway (s)	5.9	5.1	4.9	5.3
Degree Utilization, x	0.22	0.33	0.03	0.08
Capacity (veh/h)	588	684	674	627
Control Delay (s)	10.6	10.7	8.0	8.7
Approach Delay (s)	10.6	10.7	8.0	8.7
Approach LOS	B	B	A	A

Intersection Summary			
Delay	10.3		
HCM Level of Service	B		
Intersection Capacity Utilization	19.3%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Wellsville North Alternative - PM Peak Hour

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action - (Improved)
35: 207th & Evening Star Rd — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	10	5	100	10	5	90
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	20	10	200	20	10	180
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			30		445	25
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			30		445	25
tC, single (s)			5.1		6.4	7.1
tC, 2 stage (s)						
tF (s)			3.1		3.5	4.1
p0 queue free %			82		98	79
cM capacity (veh/h)			1134		473	853

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	30	220	190
Volume Left	0	200	10
Volume Right	10	0	180
cSH	1700	1134	819
Volume to Capacity	0.02	0.18	0.23
Queue Length 95th (ft)	0	16	22
Control Delay (s)	0.0	8.2	10.7
Lane LOS		A	B
Approach Delay (s)	0.0	8.2	10.7
Approach LOS			B

Intersection Summary			
Average Delay	8.7		
Intersection Capacity Utilization	25.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2010 Wellsville Alternative Action - (Improved)
36: 215th & Evening Star Rd — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	5	5	80	100	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	10	10	160	200	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	170				100	90
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	170				100	90
tC, single (s)	4.1				7.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				4.4	3.3
p0 queue free %	100				72	99
cM capacity (veh/h)	1420				711	973

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	10	170	210
Volume Left	0	0	200
Volume Right	0	160	10
cSH	1420	1700	720
Volume to Capacity	0.00	0.10	0.29
Queue Length 95th (ft)	0	0	30
Control Delay (s)	0.0	0.0	12.0
Lane LOS			B
Approach Delay (s)	0.0	0.0	12.0
Approach LOS			B

Intersection Summary			
Average Delay	6.5		
Intersection Capacity Utilization	17.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Wellsville - (Improved)
1: 175th Street & Waverly Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	70	330	5	0	60	60	5	90	5	100	30	20
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	84	398	6	0	72	72	6	108	6	120	36	24

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	488	145	120	181
Volume Left (vph)	84	0	6	120
Volume Right (vph)	6	72	6	24
Hadj (s)	0.09	-0.23	0.01	0.13
Departure Headway (s)	5.2	5.4	6.0	6.0
Degree Utilization, x	0.70	0.21	0.20	0.30
Capacity (veh/h)	677	608	524	542
Control Delay (s)	19.2	9.8	10.5	11.5
Approach Delay (s)	19.2	9.8	10.5	11.5
Approach LOS	C	A	B	B

Intersection Summary			
Delay	15.1		
HCM Level of Service	C		
Intersection Capacity Utilization	49.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Wellsville - (Improved)
2: US 56 & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	630	70	110	240	120	80	360	220	160	230	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.99			0.96		1.00	0.94		1.00	0.98	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3397			3184		1805	1723		1736	1804	
Flt Permitted		0.87			0.56		0.57	1.00		0.22	1.00	
Satd. Flow (perm)		2974			1803		1079	1723		407	1804	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	57	724	80	126	276	138	92	414	253	184	264	34
RTOR Reduction (vph)	0	13	0	0	57	0	0	32	0	0	8	0
Lane Group Flow (vph)	0	848	0	0	483	0	92	635	0	184	290	0
Heavy Vehicles (%)	2%	5%	1%	7%	9%	6%	0%	4%	4%	4%	4%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		20.1			20.1		28.2	28.2		28.2	28.2	
Effective Green, g (s)		20.1			20.1		28.2	28.2		28.2	28.2	
Actuated g/C Ratio		0.34			0.34		0.47	0.47		0.47	0.47	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		996			604		507	810		191	848	
v/s Ratio Prot								0.37			0.16	
v/s Ratio Perm		c0.29			0.27		0.09			c0.45		
v/c Ratio		0.85			0.80		0.18	0.78		0.96	0.34	
Uniform Delay, d1		18.6			18.1		9.2	13.3		15.4	10.0	
Progression Factor		1.00			0.74		1.00	1.00		1.00	1.00	
Incremental Delay, d2		9.1			10.5		0.2	5.0		54.1	0.2	
Delay (s)		27.7			23.9		9.4	18.3		69.5	10.3	
Level of Service		C			C		A	B		E	B	
Approach Delay (s)		27.7			23.9			17.2			32.9	
Approach LOS		C			C			B			C	

Intersection Summary			
HCM Average Control Delay	24.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	11.7
Intersection Capacity Utilization	95.5%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 No-Action Wellsville - (Improved)
8: US-56 & I-35 SB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1970	50	30	540	0	0	0	0	60	0	1060
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		1.00		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3546		1687	3689					1641		2760
Flt Permitted		1.00		0.95	1.00					0.95		1.00
Satd. Flow (perm)		3546		1687	3689					1641		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2074	53	32	568	0	0	0	0	63	0	1116
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	107
Lane Group Flow (vph)	0	2125	0	32	568	0	0	0	0	63	0	1009
Heavy Vehicles (%)	0%	1%	18%	7%	3%	0%	0%	0%	0%	10%	0%	3%
Turn Type				Prot						custom		custom
Protected Phases		2		1	6							5
Permitted Phases										4		4
Actuated Green, G (s)		53.0		2.8	24.8					4.2		35.2
Effective Green, g (s)		53.0		2.8	24.8					4.2		35.2
Actuated g/C Ratio		0.71		0.04	0.33					0.06		0.47
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2506		63	1220					92		1479
v/s Ratio Prot		c0.60		0.02	c0.15							c0.28
v/s Ratio Perm										0.04		0.08
v/c Ratio		0.85		0.51	0.47					0.68		0.68
Uniform Delay, d1		8.1		35.4	19.9					34.8		15.5
Progression Factor		0.81		1.18	0.84					1.00		1.00
Incremental Delay, d2		2.4		5.4	1.1					19.0		1.3
Delay (s)		8.9		47.3	17.7					53.8		16.8
Level of Service		A		D	B					D		B
Approach Delay (s)		8.9			19.3			0.0			18.8	
Approach LOS		A			B			A			B	

Intersection Summary			
HCM Average Control Delay	13.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	66.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 No-Action Wellsville - (Improved)
9: US-56 & I-35 NB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	400	0	0	400	140	170	0	100	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			0.97			0.95				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3725			1798			1637				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3725			1798			1637				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	455	0	0	455	159	193	0	114	0	0	0
RTOR Reduction (vph)	0	0	0	0	13	0	0	33	0	0	0	0
Lane Group Flow (vph)	0	455	0	0	601	0	0	274	0	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	2%	8%	0%	5%	0%	0%	0%
Turn Type							Perm					
Protected Phases		2			6			8				
Permitted Phases							8					
Actuated Green, G (s)		47.4			47.4			17.6				
Effective Green, g (s)		47.4			47.4			17.6				
Actuated g/C Ratio		0.63			0.63			0.23				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		2354			1136			384				
v/s Ratio Prot		0.12			c0.33							
v/s Ratio Perm								0.17				
v/c Ratio		0.19			0.53			0.71				
Uniform Delay, d1		5.8			7.6			26.4				
Progression Factor		0.34			1.00			1.00				
Incremental Delay, d2		0.1			1.8			6.2				
Delay (s)		2.1			9.4			32.6				
Level of Service		A			A			C				
Approach Delay (s)		2.1			9.4			32.6			0.0	
Approach LOS		A			A			C			A	

Intersection Summary			
HCM Average Control Delay	12.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	104.3%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

2015 Wellsville North No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 No-Action Wellsville - (Improved)

11: Waverly Road & US 56

AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	20	0	10	10	10	70	290	0	5	90	10
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	25	0	13	13	13	89	367	0	6	114	13
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	696	684	367	690	677	120	127			367		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	696	684	367	690	677	120	127			367		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.3	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.4	2.2			2.2		
p0 queue free %	100	93	100	96	96	99	94			99		
cM capacity (veh/h)	327	349	683	325	352	910	1453			1203		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	25	38	456	133
Volume Left	0	13	89	6
Volume Right	0	13	0	13
cSH	349	428	1453	1203
Volume to Capacity	0.07	0.09	0.06	0.01
Queue Length 95th (ft)	6	7	5	0
Control Delay (s)	16.1	14.2	2.0	0.4
Lane LOS	C	B	A	A
Approach Delay (s)	16.1	14.2	2.0	0.4
Approach LOS	C	B		

Intersection Summary			
Average Delay	2.9		
Intersection Capacity Utilization	40.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Wellsville - (Improved)

13: 183rd Street & US 56

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	10	0	10	10	5	0	360	10	0	100	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	13	0	13	13	6	0	456	13	0	127	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	604	598	130	598	595	462	133			468		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	604	598	130	598	595	462	133			468		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	97	100	97	97	99	100			100		
cM capacity (veh/h)	399	418	925	407	420	604	1464			1104		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	19	32	468	133
Volume Left	6	13	0	0
Volume Right	0	6	13	6
cSH	412	441	1464	1104
Volume to Capacity	0.05	0.07	0.00	0.00
Queue Length 95th (ft)	4	6	0	0
Control Delay (s)	14.2	13.8	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	14.2	13.8	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	29.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Wellsville - (Improved)

16: Four Corners Road & US 56

AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	10	0	10	10	10	360	0	5	100	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	7	7	13	0	13	13	13	474	0	7	132	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	664	645	474	661	645	132	132			474		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	664	645	474	661	645	132	132			474		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	98	100	97	99	99			99		
cM capacity (veh/h)	357	388	595	361	388	923	1466			1099		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	26	26	487	138
Volume Left	7	0	13	7
Volume Right	13	13	0	0
cSH	458	546	1466	1099
Volume to Capacity	0.06	0.05	0.01	0.01
Queue Length 95th (ft)	5	4	1	0
Control Delay (s)	13.3	11.9	0.3	0.4
Lane LOS	B	B	A	A
Approach Delay (s)	13.3	11.9	0.3	0.4
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.3		
Intersection Capacity Utilization	34.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Wellsville - (Improved)

17: 191st Street & US 56

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	10	10	5	0	0	5	0	380	5	0	100	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	13	13	6	0	0	6	0	494	6	0	130	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	636	633	133	643	633	497	136			500		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	636	633	133	643	633	497	136			500		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	97	99	100	100	99	100			100		
cM capacity (veh/h)	389	400	921	377	400	577	1460			1075		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	32	6	500	136
Volume Left	13	0	0	0
Volume Right	6	6	6	6
cSH	445	577	1460	1075
Volume to Capacity	0.07	0.01	0.00	0.00
Queue Length 95th (ft)	6	1	0	0
Control Delay (s)	13.7	11.3	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	13.7	11.3	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	35.0%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Wellsville North No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

24: Sunflower Road & US 56

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	10	30	0	0	10	380	60	5	110	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	6	13	38	0	0	13	481	76	6	139	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	696	734	139	712	696	519	139			557		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	696	734	139	712	696	519	139			557		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	89	100	100	99			99		
cM capacity (veh/h)	355	345	914	333	362	561	1457			1024		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	25	38	570	146
Volume Left	6	38	13	6
Volume Right	13	0	76	0
cSH	506	333	1457	1024
Volume to Capacity	0.05	0.11	0.01	0.01
Queue Length 95th (ft)	4	10	1	0
Control Delay (s)	12.5	17.2	0.3	0.4
Lane LOS	B	C	A	A
Approach Delay (s)	12.5	17.2	0.3	0.4
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	39.2%	ICU Level of Service	A
Analysis Period (min)	15		

25: US 56 & 4th Street

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	400	60	20	130	20	50
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	513	77	26	167	26	64
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			590		769	551
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			590		769	551
tC, single (s)			4.1		6.5	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.6	3.3
p0 queue free %			97		93	88
cM capacity (veh/h)			976		353	534

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	590	192	90
Volume Left	0	26	26
Volume Right	77	0	64
cSH	1700	976	466
Volume to Capacity	0.35	0.03	0.19
Queue Length 95th (ft)	0	2	18
Control Delay (s)	0.0	1.4	14.6
Lane LOS		A	B
Approach Delay (s)	0.0	1.4	14.6
Approach LOS			B

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	35.5%	ICU Level of Service	A
Analysis Period (min)	15		

28: I-35 SB Ramps & Sunflower Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	10	0	80	5	30	0	0	370	20
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	0	0	0	11	0	92	6	34	0	0	425	23
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	575	483	437	483	494	34	448			34		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	575	483	437	483	494	34	448			34		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	98	100	91	99			100		
cM capacity (veh/h)	392	484	624	479	477	1041	1123			1590		

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	103	40	448
Volume Left	11	6	0
Volume Right	92	0	23
cSH	921	1123	1700
Volume to Capacity	0.11	0.01	0.26
Queue Length 95th (ft)	9	0	0
Control Delay (s)	9.4	1.2	0.0
Lane LOS	A	A	
Approach Delay (s)	9.4	1.2	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	32.8%	ICU Level of Service	A
Analysis Period (min)	15		

29: I-35 NB Ramps & Sunflower Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	20	0	5	0	0	0	0	20	60	370	20	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	23	0	6	0	0	0	0	23	69	425	23	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	931	966	23	937	931	57	23			92		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	931	966	23	937	931	57	23			92		
tC, single (s)	7.2	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	88	100	99	100	100	100	100			72		
cM capacity (veh/h)	191	184	1060	192	193	1014	1605			1509		

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	29	92	448
Volume Left	23	0	425
Volume Right	6	69	0
cSH	228	1700	1509
Volume to Capacity	0.13	0.05	0.28
Queue Length 95th (ft)	11	0	29
Control Delay (s)	23.0	0.0	8.0
Lane LOS	C		A
Approach Delay (s)	23.0	0.0	8.0
Approach LOS	C		

Intersection Summary			
Average Delay	7.5		
Intersection Capacity Utilization	38.2%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Wellsville North No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 No-Action Wellsville - (Improved)
31: US 56 & Edgerton Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✣			✣			✣			✣	
Volume (veh/h)	5	290	20	20	80	10	20	10	60	20	10	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	315	22	22	87	11	22	11	65	22	11	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	98			337			478	478	326	543	484	92
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	98			337			478	478	326	543	484	92
tC, single (s)	4.1			4.2			7.2	6.7	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.3			3.5	4.2	3.3	3.5	4.0	3.3
p0 queue free %	100			98			95	98	91	95	98	100
cM capacity (veh/h)	1508			1179			476	451	715	398	475	970

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	342	120	98	33
Volume Left	5	22	22	22
Volume Right	22	11	65	0
cSH	1508	1179	608	421
Volume to Capacity	0.00	0.02	0.16	0.08
Queue Length 95th (ft)	0	1	14	6
Control Delay (s)	0.2	1.6	12.1	14.3
Lane LOS	A	A	B	B
Approach Delay (s)	0.2	1.6	12.1	14.3
Approach LOS			B	B

Intersection Summary			
Average Delay	3.2		
Intersection Capacity Utilization	29.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Wellsville - (Improved)
32: 207th & Sunflower Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✣			✣			✣			✣	
Volume (veh/h)	0	0	120	5	0	5	30	130	0	5	170	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	0	152	6	0	6	38	165	0	6	215	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	475	468	215	620	468	165	215			165		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	475	468	215	620	468	165	215			165		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	82	98	100	99	97			100		
cM capacity (veh/h)	488	479	827	321	479	885	1349			1426		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	152	13	203	222
Volume Left	0	6	38	6
Volume Right	152	6	0	0
cSH	827	471	1349	1426
Volume to Capacity	0.18	0.03	0.03	0.00
Queue Length 95th (ft)	17	2	2	0
Control Delay (s)	10.3	12.9	1.6	0.3
Lane LOS	B	B	A	A
Approach Delay (s)	10.3	12.9	1.6	0.3
Approach LOS	B	B		

Intersection Summary			
Average Delay	3.6		
Intersection Capacity Utilization	35.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Wellsville - (Improved)
33: 207th & COOP Rd — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		✣	✣		✣	
Volume (veh/h)	10	80	20	10	40	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	14	108	27	14	54	14
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	41				169	34
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	41				169	34
tC, single (s)	4.1				6.4	6.4
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.5
p0 queue free %	99				93	99
cM capacity (veh/h)	1582				819	990

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	122	41	68
Volume Left	14	0	54
Volume Right	0	14	14
cSH	1582	1700	848
Volume to Capacity	0.01	0.02	0.08
Queue Length 95th (ft)	1	0	6
Control Delay (s)	0.9	0.0	9.6
Lane LOS	A		A
Approach Delay (s)	0.9	0.0	9.6
Approach LOS			A

Intersection Summary			
Average Delay	3.3		
Intersection Capacity Utilization	21.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Wellsville - (Improved)
34: 207th & Edgerton Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✣			✣			✣			✣	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	10	0	0	5	20	0	10	0	80	5	5
Peak Hour Factor	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Hourly flow rate (vph)	15	15	0	0	8	30	0	15	0	121	8	8

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	30	38	15	136
Volume Left (vph)	15	0	0	121
Volume Right (vph)	0	30	0	8
Hadj (s)	0.10	-0.28	0.17	0.18
Departure Headway (s)	4.4	4.0	4.4	4.2
Degree Utilization, x	0.04	0.04	0.02	0.16
Capacity (veh/h)	788	862	798	832
Control Delay (s)	7.5	7.2	7.4	8.1
Approach Delay (s)	7.5	7.2	7.4	8.1
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.8		
HCM Level of Service	A		
Intersection Capacity Utilization	26.1%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Wellsville North No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

35: 207th & Evening Star Rd

AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	10	0	5	10	0	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	20	0	10	20	0	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			20		60	20
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			20		60	20
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		100	99
cM capacity (veh/h)			1609		946	1064

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	20	30	10
Volume Left	0	10	0
Volume Right	0	0	10
cSH	1700	1609	1064
Volume to Capacity	0.01	0.01	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	2.4	8.4
Lane LOS		A	A
Approach Delay (s)	0.0	2.4	8.4
Approach LOS			A

Intersection Summary			
Average Delay	2.6		
Intersection Capacity Utilization	15.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Wellsville - (Improved)

36: 215th & Evening Star Rd

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	0	0	0	5	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	0	0	0	10	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	0				0	0
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	0				0	0
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	99
cM capacity (veh/h)	1636				1029	1091

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	0	0	20
Volume Left	0	0	10
Volume Right	0	0	10
cSH	1700	1700	1059
Volume to Capacity	0.00	0.00	0.02
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	0.0	8.5
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.5
Approach LOS			A

Intersection Summary			
Average Delay	8.5		
Intersection Capacity Utilization	6.7%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Wellsville North No Action - (Improved) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 No-Action Wellsville - (Improved)

1: 175th Street & Waverly Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	100	5	5	320	90	10	20	5	40	20	20
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	24	120	6	6	386	108	12	24	6	48	24	24

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	151	500	42	96
Volume Left (vph)	24	6	12	48
Volume Right (vph)	6	108	6	24
Hadj (s)	0.08	-0.07	-0.03	-0.02
Departure Headway (s)	4.9	4.4	5.6	5.4
Degree Utilization, x	0.21	0.61	0.07	0.15
Capacity (veh/h)	683	793	558	586
Control Delay (s)	9.2	14.1	8.9	9.4
Approach Delay (s)	9.2	14.1	8.9	9.4
Approach LOS	A	B	A	A

Intersection Summary			
Delay	12.3		
HCM Level of Service	B		
Intersection Capacity Utilization	37.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Wellsville - (Improved)

2: US 56 & Gardner Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	310	60	250	720	250	70	170	160	160	170	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.98			0.97		1.00	0.93		1.00	0.97	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3325			3390		1787	1694		1736	1773	
Flt Permitted		0.78			0.75		0.54	1.00		0.34	1.00	
Satd. Flow (perm)		2598			2551		1009	1694		627	1773	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	34	356	69	287	828	287	80	195	184	184	195	57
RTOR Reduction (vph)	0	21	0	0	33	0	0	49	0	0	15	0
Lane Group Flow (vph)	0	438	0	0	1369	0	80	330	0	184	237	0
Heavy Vehicles (%)	0%	7%	2%	1%	3%	1%	1%	4%	4%	4%	4%	2%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		37.8			37.8		20.5	20.5		20.5	20.5	
Effective Green, g (s)		37.8			37.8		20.5	20.5		20.5	20.5	
Actuated g/C Ratio		0.54			0.54		0.29	0.29		0.29	0.29	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1403			1378		295	496		184	519	
v/s Ratio Prot								0.19			0.13	
v/s Ratio Perm		0.17			c0.54		0.08			c0.29		
v/c Ratio		0.31			0.99		0.27	0.67		1.00	0.46	
Uniform Delay, d1		8.9			16.0		19.0	21.7		24.7	20.2	
Progression Factor		1.00			0.32		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.6			21.4		0.5	3.4		66.3	0.6	
Delay (s)		9.5			26.5		19.5	25.1		91.1	20.8	
Level of Service		A			C		B	C		F	C	
Approach Delay (s)		9.5			26.5			24.1			50.5	
Approach LOS		A			C			C			D	

Intersection Summary			
HCM Average Control Delay	27.1	HCM Level of Service	C
HCM Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	11.7
Intersection Capacity Utilization	93.6%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 No-Action Wellsville - (Improved)

8: US-56 & I-35 SB Ramps

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1510	240	120	530	0	0	0	0	140	0	1380
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		4.0	5.0					5.0		2.5
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		0.98		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3462		1719	3725					1787		2787
Flt Permitted		1.00		0.28	1.00					0.95		1.00
Satd. Flow (perm)		3462		506	3725					1787		2787
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1589	253	126	558	0	0	0	0	147	0	1453
RTOR Reduction (vph)	0	14	0	0	0	0	0	0	0	0	0	40
Lane Group Flow (vph)	0	1828	0	126	558	0	0	0	0	147	0	1413
Heavy Vehicles (%)	0%	2%	3%	5%	2%	0%	0%	0%	0%	1%	0%	2%
Turn Type				pm+pt						custom		custom
Protected Phases		2		1	6							5
Permitted Phases				6						4		4
Actuated Green, G (s)		48.0		20.7	20.7					11.6		46.8
Effective Green, g (s)		48.0		20.7	20.7					11.6		46.8
Actuated g/C Ratio		0.60		0.26	0.26					0.14		0.58
Clearance Time (s)		5.0		4.0	5.0					5.0		2.5
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2077		228	964					259		1717
v/s Ratio Prot		c0.53		0.04	c0.15							c0.36
v/s Ratio Perm				0.10						0.08		0.15
v/c Ratio		0.88		0.55	0.58					0.57		0.82
Uniform Delay, d1		13.6		24.4	25.8					31.9		13.3
Progression Factor		0.63		0.83	0.86					1.00		1.00
Incremental Delay, d2		4.0		2.6	2.3					2.8		3.3
Delay (s)		12.5		22.9	24.5					34.7		16.6
Level of Service		B		C	C					C		B
Approach Delay (s)		12.5			24.2			0.0			18.3	
Approach LOS		B			C			A			B	

Intersection Summary			
HCM Average Control Delay	16.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	74.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 No-Action Wellsville - (Improved)

9: US-56 & I-35 NB Ramps

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	530	0	0	560	20	90	0	40	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			1.00			0.96				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3762			1850			1608				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3762			1850			1608				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	602	0	0	636	23	102	0	45	0	0	0
RTOR Reduction (vph)	0	0	0	0	1	0	0	22	0	0	0	0
Lane Group Flow (vph)	0	602	0	0	658	0	0	125	0	0	0	0
Heavy Vehicles (%)	0%	1%	0%	0%	2%	9%	7%	0%	15%	0%	0%	0%
Turn Type							Perm					
Protected Phases		2			6			8				
Permitted Phases							8					
Actuated Green, G (s)		58.5			58.5			11.5				
Effective Green, g (s)		58.5			58.5			11.5				
Actuated g/C Ratio		0.73			0.73			0.14				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		2751			1353			231				
v/s Ratio Prot		0.16			c0.36							
v/s Ratio Perm								0.08				
v/c Ratio		0.22			0.49			0.54				
Uniform Delay, d1		3.4			4.5			31.8				
Progression Factor		0.45			1.00			1.00				
Incremental Delay, d2		0.1			1.3			2.4				
Delay (s)		1.7			5.7			34.2				
Level of Service		A			A			C				
Approach Delay (s)		1.7			5.7			34.2			0.0	
Approach LOS		A			A			C			A	

Intersection Summary			
HCM Average Control Delay	7.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	72.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

2015 Wellsville North No Action - (Improved) - PM Peak Hour - Synchro Intersection LOS

11: Waverly Road & US 56

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	10	5	10	5	20	20	140	0	5	300	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	13	6	13	6	25	25	177	0	6	380	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	652	627	177	636	623	383	386			177		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	652	627	177	636	623	383	386			177		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	100	97	99	96	98	96	98			100		
cM capacity (veh/h)	357	393	871	360	394	658	1183			1411		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	19	44	203	392
Volume Left	0	13	25	6
Volume Right	6	25	0	6
cSH	481	494	1183	1411
Volume to Capacity	0.04	0.09	0.02	0.00
Queue Length 95th (ft)	3	7	2	0
Control Delay (s)	12.8	13.0	1.2	0.2
Lane LOS	B	B	A	A
Approach Delay (s)	12.8	13.0	1.2	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	34.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study
2015 No-Action Wellsville - (Improved)
PM Peak Hour

13: 183rd Street & US 56

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	10	0	10	10	0	0	160	20	0	310	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	13	0	13	13	0	0	203	25	0	392	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	614	620	392	614	608	215	392			228		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	614	620	392	614	608	215	392			228		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	97	100	97	97	100	100			100		
cM capacity (veh/h)	397	406	661	397	413	830	1177			1352		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	19	25	228	392
Volume Left	6	13	0	0
Volume Right	0	0	25	0
cSH	403	405	1177	1352
Volume to Capacity	0.05	0.06	0.00	0.00
Queue Length 95th (ft)	4	5	0	0
Control Delay (s)	14.4	14.5	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	14.4	14.5	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.0		
Intersection Capacity Utilization	26.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study
2015 No-Action Wellsville - (Improved)
PM Peak Hour

16: Four Corners Road & US 56

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	5	0	5	5	5	180	5	10	320	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	7	7	7	0	7	7	7	237	7	13	421	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	711	701	240	711	704	421	421			243		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	711	701	240	711	704	421	421			243		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	100	98	99	99			99		
cM capacity (veh/h)	338	360	804	339	358	637	1149			1335		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	20	13	250	434
Volume Left	7	0	7	13
Volume Right	7	7	7	0
cSH	430	459	1149	1335
Volume to Capacity	0.05	0.03	0.01	0.01
Queue Length 95th (ft)	4	2	0	1
Control Delay (s)	13.8	13.1	0.3	0.3
Lane LOS	B	B	A	A
Approach Delay (s)	13.8	13.1	0.3	0.3
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	33.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study
2015 No-Action Wellsville - (Improved)
PM Peak Hour

17: 191st Street & US 56

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	0	0	5	5	0	0	170	0	0	320	10
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	0	0	0	6	6	0	0	221	0	0	416	13
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	646	643	422	643	649	221	429			221		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	646	643	422	643	649	221	429			221		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	98	98	100	100			100		
cM capacity (veh/h)	382	395	636	389	391	824	1142			1360		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	0	13	221	429
Volume Left	0	6	0	0
Volume Right	0	0	0	13
cSH	1700	390	1142	1360
Volume to Capacity	0.00	0.03	0.00	0.00
Queue Length 95th (ft)	0	3	0	0
Control Delay (s)	0.0	14.5	0.0	0.0
Lane LOS	A	B		
Approach Delay (s)	0.0	14.5	0.0	0.0
Approach LOS	A	B		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	27.4%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Wellsville North No Action - (Improved) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2015 No-Action Wellsville - (Improved)
24: Sunflower Road & US 56 — PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	5	10	30	5	0	10	180	40	0	380	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	6	13	38	6	0	13	228	51	0	481	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	766	788	484	778	766	253	487			278		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	766	788	484	778	766	253	487			278		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	98	98	87	98	100	99			100		
cM capacity (veh/h)	315	322	587	298	331	790	1086			1296		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	19	44	291	487
Volume Left	0	38	13	0
Volume Right	13	0	51	6
cSH	460	303	1086	1296
Volume to Capacity	0.04	0.15	0.01	0.00
Queue Length 95th (ft)	3	13	1	0
Control Delay (s)	13.2	18.9	0.5	0.0
Lane LOS	B	C	A	
Approach Delay (s)	13.2	18.9	0.5	0.0
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	35.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Wellsville - (Improved)
25: US 56 & 4th Street — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	190	20	60	350	70	40
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	244	26	77	449	90	51
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			269		859	256
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			269		859	256
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			94		71	93
cM capacity (veh/h)			1306		309	787

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	269	526	141
Volume Left	0	77	90
Volume Right	26	0	51
cSH	1700	1306	396
Volume to Capacity	0.16	0.06	0.36
Queue Length 95th (ft)	0	5	39
Control Delay (s)	0.0	1.7	19.0
Lane LOS		A	C
Approach Delay (s)	0.0	1.7	19.0
Approach LOS			C

Intersection Summary			
Average Delay	3.8		
Intersection Capacity Utilization	49.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Wellsville - (Improved)
28: I-35 SB Ramps & Sunflower Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	70	0	350	10	20	0	0	150	30
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	0	0	0	80	0	402	11	23	0	0	172	34
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	638	236	190	236	253	23	207			23		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	638	236	190	236	253	23	207			23		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.2			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.3			2.2		
p0 queue free %	100	100	100	89	100	62	99			100		
cM capacity (veh/h)	241	663	857	716	648	1057	1318			1605		

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	483	34	207
Volume Left	80	11	0
Volume Right	402	0	34
cSH	979	1318	1700
Volume to Capacity	0.49	0.01	0.12
Queue Length 95th (ft)	70	1	0
Control Delay (s)	12.2	2.6	0.0
Lane LOS	B	A	
Approach Delay (s)	12.2	2.6	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	8.3		
Intersection Capacity Utilization	42.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 No-Action Wellsville - (Improved)
29: I-35 NB Ramps & Sunflower Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	20	0	5	0	0	0	0	10	20	140	80	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	23	0	6	0	0	0	0	11	23	161	92	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	437	448	92	443	437	23	92			34		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	437	448	92	443	437	23	92			34		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	95	100	99	100	100	100	100			90		
cM capacity (veh/h)	492	457	971	485	464	1060	1515			1577		

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	29	34	253
Volume Left	23	0	161
Volume Right	6	23	0
cSH	546	1700	1577
Volume to Capacity	0.05	0.02	0.10
Queue Length 95th (ft)	4	0	9
Control Delay (s)	12.0	0.0	5.1
Lane LOS	B		A
Approach Delay (s)	12.0	0.0	5.1
Approach LOS	B		

Intersection Summary			
Average Delay	5.2		
Intersection Capacity Utilization	28.6%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Wellsville North No Action - (Improved) - PM Peak Hour - Synchro Intersection LOS

31: US 56 & Edgerton Rd

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	130	20	40	260	10	20	10	10	20	10	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	141	22	43	283	11	22	11	11	22	11	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	293			163			549	543	152	554	549	288
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	293			163			549	543	152	554	549	288
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.2	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			97			95	97	99	95	97	99
cM capacity (veh/h)	1280			1410			426	434	899	413	431	756

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	168	337	43	38
Volume Left	5	43	22	22
Volume Right	22	11	11	5
cSH	1280	1410	493	447
Volume to Capacity	0.00	0.03	0.09	0.09
Queue Length 95th (ft)	0	2	7	7
Control Delay (s)	0.3	1.2	13.0	13.8
Lane LOS	A	A	B	B
Approach Delay (s)	0.3	1.2	13.0	13.8
Approach LOS			B	B

Intersection Summary			
Average Delay	2.6		
Intersection Capacity Utilization	38.2%	ICU Level of Service	A
Analysis Period (min)	15		

32: 207th & Sunflower Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	0	50	5	5	10	100	170	5	5	180	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	0	63	6	6	13	127	215	6	6	228	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	731	718	231	778	718	218	234			222		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	731	718	231	778	718	218	234			222		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	100	92	98	98	98	91			100		
cM capacity (veh/h)	305	322	803	269	322	826	1339			1359		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	70	25	348	241
Volume Left	6	6	127	6
Volume Right	63	13	6	6
cSH	699	433	1339	1359
Volume to Capacity	0.10	0.06	0.09	0.00
Queue Length 95th (ft)	8	5	8	0
Control Delay (s)	10.7	13.8	3.4	0.2
Lane LOS	B	B	A	A
Approach Delay (s)	10.7	13.8	3.4	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	3.4		
Intersection Capacity Utilization	38.5%	ICU Level of Service	A
Analysis Period (min)	15		

33: 207th & COOP Rd

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	40	70	40	20	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	14	54	95	54	27	14
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	149				203	122
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	149				203	122
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				96	99
cM capacity (veh/h)	1445				772	935

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	68	149	41
Volume Left	14	0	27
Volume Right	0	54	14
cSH	1445	1700	819
Volume to Capacity	0.01	0.09	0.05
Queue Length 95th (ft)	1	0	4
Control Delay (s)	1.6	0.0	9.6
Lane LOS	A		A
Approach Delay (s)	1.6	0.0	9.6
Approach LOS			A

Intersection Summary			
Average Delay	1.9		
Intersection Capacity Utilization	19.3%	ICU Level of Service	A
Analysis Period (min)	15		

34: 207th & Edgerton Rd

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	10	0	10	10	60	5	5	0	30	5	10
Peak Hour Factor	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Hourly flow rate (vph)	8	15	0	15	15	91	8	8	0	45	8	15

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	23	121	15	68
Volume Left (vph)	8	15	8	45
Volume Right (vph)	0	91	0	15
Hadj (s)	0.07	-0.40	0.10	0.00
Departure Headway (s)	4.3	3.7	4.4	4.2
Degree Utilization, x	0.03	0.12	0.02	0.08
Capacity (veh/h)	819	946	787	825
Control Delay (s)	7.4	7.2	7.4	7.6
Approach Delay (s)	7.4	7.2	7.4	7.6
Approach LOS	A	A	A	A

Intersection Summary			
Delay	7.4		
HCM Level of Service	A		
Intersection Capacity Utilization	15.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2015 No-Action Wellsville - (Improved)
35: 207th & Evening Star Rd | PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	10	5	5	10	5	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	20	10	10	20	10	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			30		65	25
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			30		65	25
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		99	100
cM capacity (veh/h)			1596		940	1057

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	30	30	10
Volume Left	0	10	10
Volume Right	10	0	0
cSH	1700	1596	940
Volume to Capacity	0.02	0.01	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	2.5	8.9
Lane LOS		A	A
Approach Delay (s)	0.0	2.5	8.9
Approach LOS			A

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	15.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2015 No-Action Wellsville - (Improved)
36: 215th & Evening Star Rd | PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	5	5	0	5	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	10	10	0	10	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	10				20	10
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	10				20	10
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	99
cM capacity (veh/h)	1623				1002	1077

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	10	10	20
Volume Left	0	0	10
Volume Right	0	0	10
cSH	1623	1700	1038
Volume to Capacity	0.00	0.01	0.02
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	0.0	8.5
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.5
Approach LOS			A

Intersection Summary			
Average Delay	4.3		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Wellsville North Alternative - AM Peak Hour

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action

1: 175th Street & Waverly Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	70	330	5	0	60	60	5	100	5	100	30	20
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	84	398	6	0	72	72	6	120	6	120	36	24

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	488	145	133	181
Volume Left (vph)	84	0	6	120
Volume Right (vph)	6	72	6	24
Hadj (s)	0.09	-0.23	0.01	0.13
Departure Headway (s)	5.2	5.4	6.0	6.0
Degree Utilization, x	0.70	0.22	0.22	0.30
Capacity (veh/h)	672	599	524	538
Control Delay (s)	19.6	9.9	10.7	11.6
Approach Delay (s)	19.6	9.9	10.7	11.6
Approach LOS	C	A	B	B

Intersection Summary			
Delay	15.3		
HCM Level of Service	C		
Intersection Capacity Utilization	49.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action

2: US 56 & Gardner Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	640	70	110	250	120	80	360	220	160	230	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		2.5	5.8		2.5	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.99			0.96		1.00	0.94		1.00	0.98	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3394			3187		1805	1723		1736	1798	
Flt Permitted		0.86			0.54		0.55	1.00		0.11	1.00	
Satd. Flow (perm)		2913			1729		1054	1723		193	1798	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	57	736	80	126	287	138	92	414	253	184	264	34
RTOR Reduction (vph)	0	9	0	0	37	0	0	25	0	0	5	0
Lane Group Flow (vph)	0	864	0	0	514	0	92	642	0	184	293	0
Heavy Vehicles (%)	4%	5%	1%	7%	9%	6%	0%	4%	4%	4%	4%	3%
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		32.0			32.0		40.9	35.9		46.3	38.8	
Effective Green, g (s)		32.0			32.0		40.9	35.9		46.3	38.8	
Actuated g/C Ratio		0.36			0.36		0.45	0.40		0.51	0.43	
Clearance Time (s)		5.9			5.9		2.5	5.8		2.5	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1036			615		521	687		235	775	
v/s Ratio Prot							0.01	c0.37		c0.07	0.16	
v/s Ratio Perm		0.30			c0.30		0.07			0.33		
v/c Ratio		0.83			0.84		0.18	0.94		0.78	0.38	
Uniform Delay, d1		26.6			26.6		14.1	25.9		17.9	17.4	
Progression Factor		1.00			1.17		1.06	1.01		1.00	1.00	
Incremental Delay, d2		7.9			12.5		0.2	19.9		15.5	0.3	
Delay (s)		34.5			43.7		15.1	46.1		33.4	17.7	
Level of Service		C			D		B	D		C	B	
Approach Delay (s)		34.5			43.7			42.4			23.7	
Approach LOS		C			D			D			C	

Intersection Summary			
HCM Average Control Delay	36.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	14.2
Intersection Capacity Utilization	94.6%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action

8: US-56 & I-35 SB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1970	50	30	540	0	0	0	0	60	0	1060
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		1.00		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3544		1641	3689					1641		2760
Flt Permitted		1.00		0.95	1.00					0.95		1.00
Satd. Flow (perm)		3544		1641	3689					1641		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2074	53	32	568	0	0	0	0	63	0	1116
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	2125	0	32	568	0	0	0	0	63	0	1116
Heavy Vehicles (%)	0%	1%	20%	10%	3%	0%	0%	0%	0%	10%	0%	3%
Turn Type				Prot						Prot		custom
Protected Phases		2		1	6					7		5
Permitted Phases												4
Actuated Green, G (s)		65.1		4.2	26.8					5.7		42.5
Effective Green, g (s)		65.1		4.2	26.8					5.7		42.5
Actuated g/C Ratio		0.72		0.05	0.30					0.06		0.47
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2563		77	1099					104		1303
v/s Ratio Prot		c0.60		0.02	c0.15					c0.04		0.40
v/s Ratio Perm												
v/c Ratio		0.83		0.42	0.52					0.61		0.86
Uniform Delay, d1		8.6		41.7	26.2					41.1		21.0
Progression Factor		0.66		0.99	0.92					1.00		1.00
Incremental Delay, d2		2.2		3.1	1.5					9.6		5.8
Delay (s)		7.9		44.5	25.6					50.6		26.8
Level of Service		A		D	C					D		C
Approach Delay (s)		7.9			26.6			0.0			28.1	
Approach LOS		A			C			A			C	

Intersection Summary			
HCM Average Control Delay	16.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	66.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action

9: US-56 & I-35 NB Ramps — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	400	0	0	400	140	170	0	110	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			0.97			0.95				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3725			1798			1629				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3725			1798			1629				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	455	0	0	455	159	193	0	125	0	0	0
RTOR Reduction (vph)	0	0	0	0	11	0	0	31	0	0	0	0
Lane Group Flow (vph)	0	455	0	0	603	0	0	287	0	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	2%	8%	0%	6%	0%	0%	0%
Turn Type							Perm					
Protected Phases		2			6			8				
Permitted Phases							8					
Actuated Green, G (s)		59.0			59.0			21.0				
Effective Green, g (s)		59.0			59.0			21.0				
Actuated g/C Ratio		0.66			0.66			0.23				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		2442			1179			380				
v/s Ratio Prot		0.12			c0.34							
v/s Ratio Perm								0.18				
v/c Ratio		0.19			0.51			0.76				
Uniform Delay, d1		6.1			8.0			32.1				
Progression Factor		0.48			1.00			1.00				
Incremental Delay, d2		0.1			1.6			8.3				
Delay (s)		3.0			9.6			40.4				
Level of Service		A			A			D				
Approach Delay (s)		3.0			9.6			40.4			0.0	
Approach LOS		A			A			D			A	

Intersection Summary			
HCM Average Control Delay	14.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	104.3%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

2015 Wellsville North Alternative - AM Peak Hour

11: Waverly Road & US 56

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	20	0	10	5	20	70	300	0	5	100	10
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	25	0	13	6	25	89	380	0	6	127	13
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	731	709	380	715	703	133	139			380		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	731	709	380	715	703	133	139			380		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	92	100	96	98	97	94			99		
cM capacity (veh/h)	309	338	672	312	340	908	1438			1190		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	25	44	468	146
Volume Left	0	13	89	6
Volume Right	0	25	0	13
cSH	338	509	1438	1190
Volume to Capacity	0.08	0.09	0.06	0.01
Queue Length 95th (ft)	6	7	5	0
Control Delay (s)	16.5	12.7	1.9	0.4
Lane LOS	C	B	A	A
Approach Delay (s)	16.5	12.7	1.9	0.4
Approach LOS	C	B		

Intersection Summary			
Average Delay	2.9		
Intersection Capacity Utilization	41.7%	ICU Level of Service	A
Analysis Period (min)	15		

13: 183rd Street & US 56

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	10	0	10	10	5	0	380	10	0	110	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	13	0	13	13	6	0	481	13	0	139	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	642	636	142	636	633	487	146			494		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	642	636	142	636	633	487	146			494		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	97	100	97	97	99	100			100		
cM capacity (veh/h)	376	398	911	384	400	584	1449			1080		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	19	32	494	146
Volume Left	6	13	0	0
Volume Right	0	6	13	6
cSH	390	419	1449	1080
Volume to Capacity	0.05	0.08	0.00	0.00
Queue Length 95th (ft)	4	6	0	0
Control Delay (s)	14.7	14.3	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	14.7	14.3	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	30.6%	ICU Level of Service	A
Analysis Period (min)	15		

16: Four Corners Road & US 56

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	10	0	10	10	20	380	0	5	120	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	7	7	13	0	13	13	26	500	0	7	158	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	743	724	500	740	724	158	158			500		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	743	724	500	740	724	158	158			500		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	98	100	96	99	98			99		
cM capacity (veh/h)	313	346	575	317	346	893	1434			1075		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	26	26	526	164
Volume Left	7	0	26	7
Volume Right	13	13	0	0
cSH	418	499	1434	1075
Volume to Capacity	0.06	0.05	0.02	0.01
Queue Length 95th (ft)	5	4	1	0
Control Delay (s)	14.2	12.6	0.6	0.4
Lane LOS	B	B	A	A
Approach Delay (s)	14.2	12.6	0.6	0.4
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	39.9%	ICU Level of Service	A
Analysis Period (min)	15		

17: 191st Street & US 56

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	10	10	5	5	0	5	0	400	5	0	120	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	13	13	6	6	0	6	0	519	6	0	156	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	688	685	159	695	685	523	162			526		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	688	685	159	695	685	523	162			526		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	96	97	99	98	100	99	100			100		
cM capacity (veh/h)	359	373	891	347	373	558	1429			1051		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	32	13	526	162
Volume Left	13	6	0	0
Volume Right	6	6	6	6
cSH	415	428	1429	1051
Volume to Capacity	0.08	0.03	0.00	0.00
Queue Length 95th (ft)	6	2	0	0
Control Delay (s)	14.4	13.7	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	14.4	13.7	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	31.4%	ICU Level of Service	A
Analysis Period (min)	15		

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24: Sunflower Road & US 56 — AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	10	40	0	0	10	400	70	5	130	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	6	13	51	0	0	13	506	89	6	165	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	753	797	165	769	753	551	165			595		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	753	797	165	769	753	551	165			595		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	83	100	100	99			99		
cM capacity (veh/h)	325	317	885	302	336	538	1426			991		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	25	51	608	171
Volume Left	6	51	13	6
Volume Right	13	0	89	0
cSH	471	302	1426	991
Volume to Capacity	0.05	0.17	0.01	0.01
Queue Length 95th (ft)	4	15	1	0
Control Delay (s)	13.1	19.3	0.3	0.4
Lane LOS	B	C	A	A
Approach Delay (s)	13.1	19.3	0.3	0.4
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	42.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action
25: US 56 & 4th Street — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	430	60	20	160	20	50
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	551	77	26	205	26	64
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			628		846	590
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			628		846	590
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		92	87
cM capacity (veh/h)			939		320	508

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	628	231	90
Volume Left	0	26	26
Volume Right	77	0	64
cSH	1700	939	435
Volume to Capacity	0.37	0.03	0.21
Queue Length 95th (ft)	0	2	19
Control Delay (s)	0.0	1.2	15.4
Lane LOS		A	C
Approach Delay (s)	0.0	1.2	15.4
Approach LOS			C

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	37.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action
28: I-35 SB Ramps & Sunflower Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	10	0	190	5	40	0	0	510	20
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	0	0	0	11	0	218	6	46	0	0	586	23
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	874	655	598	655	667	46	609			46		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	874	655	598	655	667	46	609			46		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.5	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.6	2.2			2.2		
p0 queue free %	100	100	100	97	100	77	99			100		
cM capacity (veh/h)	209	386	506	367	380	944	979			1575		

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	230	52	609
Volume Left	11	6	0
Volume Right	218	0	23
cSH	876	979	1700
Volume to Capacity	0.26	0.01	0.36
Queue Length 95th (ft)	26	0	0
Control Delay (s)	10.6	1.0	0.0
Lane LOS	B	A	
Approach Delay (s)	10.6	1.0	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	2.8		
Intersection Capacity Utilization	47.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action
29: I-35 NB Ramps & Sunflower Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	20	5	5	0	0	0	0	20	60	500	20	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	23	6	6	0	0	0	0	23	69	575	23	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1230	1264	23	1239	1230	57	23			92		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1230	1264	23	1239	1230	57	23			92		
tC, single (s)	7.2	6.5	6.2	7.1	6.5	6.2	4.1			4.3		
tC, 2 stage (s)												
tF (s)	3.6	4.0	3.3	3.5	4.0	3.3	2.2			2.4		
p0 queue free %	77	94	99	100	100	100	100			59		
cM capacity (veh/h)	99	101	1060	100	106	1014	1605			1408		

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	34	92	598
Volume Left	23	0	575
Volume Right	6	69	0
cSH	117	1700	1408
Volume to Capacity	0.29	0.05	0.41
Queue Length 95th (ft)	28	0	51
Control Delay (s)	48.1	0.0	9.1
Lane LOS	E		A
Approach Delay (s)	48.1	0.0	9.1
Approach LOS	E		

Intersection Summary			
Average Delay	9.8		
Intersection Capacity Utilization	45.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action

31: US 56 & Edgerton Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	290	20	50	80	5	20	10	90	20	10	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	315	22	54	87	5	22	11	98	22	11	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	92			337			541	538	326	639	546	90
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	92			337			541	538	326	639	546	90
tC, single (s)	4.1			4.2			7.2	6.8	6.3	7.1	6.6	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.3			3.6	4.3	3.4	3.5	4.1	3.3
p0 queue free %	100			95			95	97	86	93	97	100
cM capacity (veh/h)	1515			1179			408	392	704	318	413	974

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	342	147	130	33
Volume Left	5	54	22	22
Volume Right	22	5	98	0
cSH	1515	1179	593	344
Volume to Capacity	0.00	0.05	0.22	0.09
Queue Length 95th (ft)	0	4	21	8
Control Delay (s)	0.1	3.3	12.8	16.6
Lane LOS	A	A	B	C
Approach Delay (s)	0.1	3.3	12.8	16.6
Approach LOS			B	C

Intersection Summary			
Average Delay	4.2		
Intersection Capacity Utilization	41.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action

32: 207th & Sunflower Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	270	5	0	5	140	130	0	5	170	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	0	342	6	0	6	177	165	0	6	215	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	753	747	215	1089	747	165	215			165		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	753	747	215	1089	747	165	215			165		
tC, single (s)	7.1	6.5	6.5	7.1	6.5	6.2	4.6			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.6	3.5	4.0	3.3	2.6			2.2		
p0 queue free %	100	100	54	93	100	99	84			100		
cM capacity (veh/h)	286	289	751	93	289	885	1137			1426		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	342	13	342	222
Volume Left	0	6	177	6
Volume Right	342	6	0	0
cSH	751	168	1137	1426
Volume to Capacity	0.46	0.08	0.16	0.00
Queue Length 95th (ft)	60	6	14	0
Control Delay (s)	13.7	28.1	5.3	0.3
Lane LOS	B	D	A	A
Approach Delay (s)	13.7	28.1	5.3	0.3
Approach LOS	B	D		

Intersection Summary			
Average Delay	7.5		
Intersection Capacity Utilization	50.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action

33: 207th & COOP Rd

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	230	130	10	40	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	14	311	176	14	54	14
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	189				520	182
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	189				520	182
tC, single (s)	4.1				6.4	6.4
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.5
p0 queue free %	99				89	98
cM capacity (veh/h)	1397				515	816

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	324	189	68
Volume Left	14	0	54
Volume Right	0	14	14
cSH	1397	1700	556
Volume to Capacity	0.01	0.11	0.12
Queue Length 95th (ft)	1	0	10
Control Delay (s)	0.4	0.0	12.4
Lane LOS	A		B
Approach Delay (s)	0.4	0.0	12.4
Approach LOS			B

Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	30.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action

34: 207th & Edgerton Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	40	150	0	0	120	20	0	5	0	80	5	30
Peak Hour Factor	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Hourly flow rate (vph)	61	227	0	0	182	30	0	8	0	121	8	45

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	288	212	8	174
Volume Left (vph)	61	0	0	121
Volume Right (vph)	0	30	0	45
Hadj (s)	0.93	0.71	0.34	0.08
Departure Headway (s)	5.7	5.6	6.0	5.4
Degree Utilization, x	0.45	0.33	0.01	0.26
Capacity (veh/h)	610	619	519	613
Control Delay (s)	13.3	11.3	9.1	10.3
Approach Delay (s)	13.3	11.3	9.1	10.3
Approach LOS	B	B	A	B

Intersection Summary			
Delay	11.9		
HCM Level of Service	B		
Intersection Capacity Utilization	40.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action

35: 207th & Evening Star Rd — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	5	0	150	5	0	190
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	10	0	300	10	0	380
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			10		620	10
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			10		620	10
tC, single (s)			4.6		6.4	6.7
tC, 2 stage (s)						
tF (s)			2.6		3.5	3.8
p0 queue free %			78		100	60
cM capacity (veh/h)			1370		355	940

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	10	310	380
Volume Left	0	300	0
Volume Right	0	0	380
cSH	1700	1370	940
Volume to Capacity	0.01	0.22	0.40
Queue Length 95th (ft)	0	21	49
Control Delay (s)	0.0	8.2	11.4
Lane LOS		A	B
Approach Delay (s)	0.0	8.2	11.4
Approach LOS			B

Intersection Summary			
Average Delay	9.8		
Intersection Capacity Utilization	33.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action

36: 215th & Evening Star Rd — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	5	5	180	150	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	10	10	360	300	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	370				200	190
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	370				200	190
tC, single (s)	4.1				6.8	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.9	3.3
p0 queue free %	100				57	99
cM capacity (veh/h)	1200				701	857

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	10	370	310
Volume Left	0	0	300
Volume Right	0	360	10
cSH	1200	1700	705
Volume to Capacity	0.00	0.22	0.44
Queue Length 95th (ft)	0	0	56
Control Delay (s)	0.0	0.0	14.1
Lane LOS			B
Approach Delay (s)	0.0	0.0	14.1
Approach LOS			B

Intersection Summary			
Average Delay	6.3		
Intersection Capacity Utilization	26.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)

1: 175th Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	70	330	5	0	60	60	5	100	5	100	30	20
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	84	398	6	0	72	72	6	120	6	120	36	24
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	145			404			720	714	401	744	681	108
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	145			404			720	714	401	744	681	108
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.2	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	94			100			98	64	99	46	90	97
cM capacity (veh/h)	1426			1166			296	336	654	224	350	937

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	488	145	133	181
Volume Left	84	0	6	120
Volume Right	6	72	6	24
cSH	1426	1166	341	271
Volume to Capacity	0.06	0.00	0.39	0.67
Queue Length 95th (ft)	5	0	45	109
Control Delay (s)	1.8	0.0	22.1	41.5
Lane LOS	A		C	E
Approach Delay (s)	1.8	0.0	22.1	41.5
Approach LOS			C	E

Intersection Summary			
Average Delay	12.0		
Intersection Capacity Utilization	49.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)

2: US 56 & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	640	70	110	250	120	80	360	220	160	230	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		2.5	5.8		2.5	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.99			0.96		1.00	0.94		1.00	0.98	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3394			3187		1805	1723		1736	1798	
Flt Permitted		0.86			0.54		0.55	1.00		0.11	1.00	
Satd. Flow (perm)		2913			1729		1054	1723		193	1798	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	57	736	80	126	287	138	92	414	253	184	264	34
RTOR Reduction (vph)	0	9	0	0	37	0	0	25	0	0	5	0
Lane Group Flow (vph)	0	864	0	0	514	0	92	642	0	184	293	0
Heavy Vehicles (%)	4%	5%	1%	7%	9%	6%	0%	4%	4%	4%	4%	3%
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		32.0			32.0		40.9	35.9		46.3	38.8	
Effective Green, g (s)		32.0			32.0		40.9	35.9		46.3	38.8	
Actuated g/C Ratio		0.36			0.36		0.45	0.40		0.51	0.43	
Clearance Time (s)		5.9			5.9		2.5	5.8		2.5	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1036			615		521	687		235	775	
v/s Ratio Prot							0.01	c0.37		c0.07	0.16	
v/s Ratio Perm		0.30			c0.30		0.07			0.33		
v/c Ratio		0.83			0.84		0.18	0.94		0.78	0.38	
Uniform Delay, d1		26.6			26.6		14.1	25.9		17.9	17.4	
Progression Factor		1.00			1.17		1.06	1.01		1.00	1.00	
Incremental Delay, d2		7.9			12.5		0.2	19.9		15.5	0.3	
Delay (s)		34.5			43.7		15.1	46.1		33.4	17.7	
Level of Service		C			D		B	D		C	B	
Approach Delay (s)		34.5			43.7			42.4			23.7	
Approach LOS		C			D			D			C	

Intersection Summary			
HCM Average Control Delay	36.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	14.2
Intersection Capacity Utilization	94.6%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)

8: US-56 & I-35 SB Ramps

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1970	50	30	540	0	0	0	0	60	0	1060
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		1.00		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3544		1641	3689					1641		2760
Flt Permitted		1.00		0.95	1.00					0.95		1.00
Satd. Flow (perm)		3544		1641	3689					1641		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2074	53	32	568	0	0	0	0	63	0	1116
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	2125	0	32	568	0	0	0	0	63	0	1116
Heavy Vehicles (%)	0%	1%	20%	10%	3%	0%	0%	0%	0%	10%	0%	3%
Turn Type				Prot						Prot		custom
Protected Phases		2		1	6					7		5
Permitted Phases												4
Actuated Green, G (s)		65.1		4.2	26.8					5.7		42.5
Effective Green, g (s)		65.1		4.2	26.8					5.7		42.5
Actuated g/C Ratio		0.72		0.05	0.30					0.06		0.47
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2563		77	1099					104		1303
v/s Ratio Prot		c0.60		0.02	c0.15					c0.04		0.40
v/s Ratio Perm												
v/c Ratio		0.83		0.42	0.52					0.61		0.86
Uniform Delay, d1		8.6		41.7	26.2					41.1		21.0
Progression Factor		0.66		0.99	0.92					1.00		1.00
Incremental Delay, d2		2.2		3.1	1.5					9.6		5.8
Delay (s)		7.9		44.5	25.6					50.6		26.8
Level of Service		A		D	C					D		C
Approach Delay (s)		7.9			26.6			0.0			28.1	
Approach LOS		A			C			A			C	

Intersection Summary			
HCM Average Control Delay	16.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	66.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)

9: US-56 & I-35 NB Ramps

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	400	0	0	400	140	170	0	110	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			0.97			0.95				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3725			1798			1629				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3725			1798			1629				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	455	0	0	455	159	193	0	125	0	0	0
RTOR Reduction (vph)	0	0	0	0	11	0	0	31	0	0	0	0
Lane Group Flow (vph)	0	455	0	0	603	0	0	287	0	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	2%	8%	0%	6%	0%	0%	0%
Turn Type				Perm			Perm					
Protected Phases		2			6			8				
Permitted Phases				6			8					
Actuated Green, G (s)		59.0			59.0			21.0				
Effective Green, g (s)		59.0			59.0			21.0				
Actuated g/C Ratio		0.66			0.66			0.23				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		2442			1179			380				
v/s Ratio Prot		0.12			c0.34							
v/s Ratio Perm								0.18				
v/c Ratio		0.19			0.51			0.76				
Uniform Delay, d1		6.1			8.0			32.1				
Progression Factor		0.48			1.00			1.00				
Incremental Delay, d2		0.1			1.6			8.3				
Delay (s)		3.0			9.6			40.4				
Level of Service		A			A			D				
Approach Delay (s)		3.0			9.6			40.4			0.0	
Approach LOS		A			A			D			A	

Intersection Summary			
HCM Average Control Delay	14.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	104.3%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

2015 Wellsville North Alternative - (Mitigated) - AM Peak Hour

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)
11: Waverly Road & US 56 — AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✣			✣			✣			✣	
Volume (veh/h)	0	20	0	10	5	20	70	300	0	5	100	10
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	25	0	13	6	25	89	380	0	6	127	13
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	731	709	380	715	703	133	139			380		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	731	709	380	715	703	133	139			380		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	92	100	96	98	97	94			99		
cM capacity (veh/h)	309	338	672	312	340	908	1438			1190		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	25	44	468	146
Volume Left	0	13	89	6
Volume Right	0	25	0	13
cSH	338	509	1438	1190
Volume to Capacity	0.08	0.09	0.06	0.01
Queue Length 95th (ft)	6	7	5	0
Control Delay (s)	16.5	12.7	1.9	0.4
Lane LOS	C	B	A	A
Approach Delay (s)	16.5	12.7	1.9	0.4
Approach LOS	C	B		

Intersection Summary			
Average Delay	2.9		
Intersection Capacity Utilization	41.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)
13: 183rd Street & US 56 — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✣			✣			✣			✣	
Volume (veh/h)	5	10	0	10	10	5	0	380	10	0	110	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	13	0	13	13	6	0	481	13	0	139	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	642	636	142	636	633	487	146			494		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	642	636	142	636	633	487	146			494		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	97	100	97	97	99	100			100		
cM capacity (veh/h)	376	398	911	384	400	584	1449			1080		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	19	32	494	146
Volume Left	6	13	0	0
Volume Right	0	6	13	6
cSH	390	419	1449	1080
Volume to Capacity	0.05	0.08	0.00	0.00
Queue Length 95th (ft)	4	6	0	0
Control Delay (s)	14.7	14.3	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	14.7	14.3	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	30.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)
16: Four Corners Road & US 56 — AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✣			✣			✣			✣	
Volume (veh/h)	5	5	10	0	10	10	20	380	0	5	120	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	7	7	13	0	13	13	26	500	0	7	158	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	743	724	500	740	724	158	158			500		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	743	724	500	740	724	158	158			500		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	98	100	96	99	98			99		
cM capacity (veh/h)	313	346	575	317	346	893	1434			1075		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	26	26	526	164
Volume Left	7	0	26	7
Volume Right	13	13	0	0
cSH	418	499	1434	1075
Volume to Capacity	0.06	0.05	0.02	0.01
Queue Length 95th (ft)	5	4	1	0
Control Delay (s)	14.2	12.6	0.6	0.4
Lane LOS	B	B	A	A
Approach Delay (s)	14.2	12.6	0.6	0.4
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	39.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)
17: 191st Street & US 56 — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✣			✣			✣			✣	
Volume (veh/h)	10	10	5	5	0	5	0	400	5	0	120	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	13	13	6	6	0	6	0	519	6	0	156	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	688	685	159	695	685	523	162			526		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	688	685	159	695	685	523	162			526		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	96	97	99	98	100	99	100			100		
cM capacity (veh/h)	359	373	891	347	373	558	1429			1051		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	32	13	526	162
Volume Left	13	6	0	0
Volume Right	6	6	6	6
cSH	415	428	1429	1051
Volume to Capacity	0.08	0.03	0.00	0.00
Queue Length 95th (ft)	6	2	0	0
Control Delay (s)	14.4	13.7	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	14.4	13.7	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	31.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)

24: Sunflower Road & US 56

AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	5	10	40	0	0	10	400	70	5	130	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	6	13	51	0	0	13	506	89	6	165	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	753	797	165	769	753	551	165			595		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	753	797	165	769	753	551	165			595		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	83	100	100	99			99		
cM capacity (veh/h)	325	317	885	302	336	538	1426			991		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	25	51	608	171
Volume Left	6	51	13	6
Volume Right	13	0	89	0
cSH	471	302	1426	991
Volume to Capacity	0.05	0.17	0.01	0.01
Queue Length 95th (ft)	4	15	1	0
Control Delay (s)	13.1	19.3	0.3	0.4
Lane LOS	B	C	A	A
Approach Delay (s)	13.1	19.3	0.3	0.4
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	42.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)

25: US 56 & 4th Street

AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	430	60	20	160	20	50
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	551	77	26	205	26	64
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			628		846	590
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			628		846	590
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		92	87
cM capacity (veh/h)			939		320	508

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	628	231	90
Volume Left	0	26	26
Volume Right	77	0	64
cSH	1700	939	435
Volume to Capacity	0.37	0.03	0.21
Queue Length 95th (ft)	0	2	19
Control Delay (s)	0.0	1.2	15.4
Lane LOS		A	C
Approach Delay (s)	0.0	1.2	15.4
Approach LOS			C

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	37.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)

28: I-35 SB Ramps & Sunflower Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	10	0	190	5	40	0	0	510	20
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	0	0	0	11	0	218	6	46	0	0	586	23
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								811				
pX, platoon unblocked												
vC, conflicting volume	874	655	598	655	667	46	609			46		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	874	655	598	655	667	46	609			46		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.5	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.6	2.2			2.2		
p0 queue free %	100	100	100	97	100	77	99			100		
cM capacity (veh/h)	209	386	506	367	380	944	979			1575		

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	230	52	609
Volume Left	11	6	0
Volume Right	218	0	23
cSH	876	979	1700
Volume to Capacity	0.26	0.01	0.36
Queue Length 95th (ft)	26	0	0
Control Delay (s)	10.6	1.0	0.0
Lane LOS	B	A	
Approach Delay (s)	10.6	1.0	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	2.8		
Intersection Capacity Utilization	47.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)

29: I-35 NB Ramps & Sunflower Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	5	5	0	0	0	0	20	60	500	20	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.98						0.90			1.00	
Flt Protected		0.97						1.00			0.95	
Satd. Flow (prot)		1636						1662			1543	
Flt Permitted		0.97						1.00			0.67	
Satd. Flow (perm)		1636						1662			1080	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	23	6	6	0	0	0	0	23	69	575	23	0
RTOR Reduction (vph)	0	6	0	0	0	0	0	15	0	0	0	0
Lane Group Flow (vph)	0	29	0	0	0	0	0	77	0	0	598	0
Heavy Vehicles (%)	15%	0%	0%	0%	0%	0%	0%	5%	2%	18%	5%	0%
Turn Type	Perm									Perm		
Protected Phases		4						2			6	
Permitted Phases	4									6		
Actuated Green, G (s)		2.4						45.2			45.2	
Effective Green, g (s)		2.4						45.2			45.2	
Actuated g/C Ratio		0.04						0.78			0.78	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		68						1304			848	
v/s Ratio Prot								0.05				
v/s Ratio Perm		0.02									c0.55	
v/c Ratio		0.43						0.06			0.71	
Uniform Delay, d1		26.9						1.4			3.0	
Progression Factor		1.00						1.00			1.00	
Incremental Delay, d2		4.3						0.0			2.7	
Delay (s)		31.3						1.4			5.7	
Level of Service		C						A			A	
Approach Delay (s)		31.3			0.0			1.4			5.7	
Approach LOS		C			A			A			A	

Intersection Summary			
HCM Average Control Delay	6.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	57.6	Sum of lost time (s)	10.0
Intersection Capacity Utilization	47.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)
31: US 56 & Edgerton Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	290	20	50	80	5	20	10	90	20	10	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	315	22	54	87	5	22	11	98	22	11	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	92			337			541	538	326	639	546	90
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	92			337			541	538	326	639	546	90
tC, single (s)	4.1			4.2			7.2	6.8	6.3	7.1	6.6	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.3			3.6	4.3	3.4	3.5	4.1	3.3
p0 queue free %	100			95			95	97	86	93	97	100
cM capacity (veh/h)	1515			1179			408	392	704	318	413	974

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	342	147	130	33
Volume Left	5	54	22	22
Volume Right	22	5	98	0
cSH	1515	1179	593	344
Volume to Capacity	0.00	0.05	0.22	0.09
Queue Length 95th (ft)	0	4	21	8
Control Delay (s)	0.1	3.3	12.8	16.6
Lane LOS	A	A	B	C
Approach Delay (s)	0.1	3.3	12.8	16.6
Approach LOS			B	C

Intersection Summary			
Average Delay	4.2		
Intersection Capacity Utilization	41.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)
32: 207th & Sunflower Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	270	5	0	5	140	130	0	5	170	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	0	342	6	0	6	177	165	0	6	215	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	753	747	215	1089	747	165	215			165		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	753	747	215	1089	747	165	215			165		
tC, single (s)	7.1	6.5	6.5	7.1	6.5	6.2	4.6			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.6	3.5	4.0	3.3	2.6			2.2		
p0 queue free %	100	100	54	93	100	99	84			100		
cM capacity (veh/h)	286	289	751	93	289	885	1137			1426		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	342	13	342	222
Volume Left	0	6	177	6
Volume Right	342	6	0	0
cSH	751	168	1137	1426
Volume to Capacity	0.46	0.08	0.16	0.00
Queue Length 95th (ft)	60	6	14	0
Control Delay (s)	13.7	28.1	5.3	0.3
Lane LOS	B	D	A	A
Approach Delay (s)	13.7	28.1	5.3	0.3
Approach LOS	B	D		

Intersection Summary			
Average Delay	7.5		
Intersection Capacity Utilization	50.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)
33: 207th & COOP Rd — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	230	130	10	40	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	14	311	176	14	54	14
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	189				520	182
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	189				520	182
tC, single (s)	4.1				6.4	6.4
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.5
p0 queue free %	99				89	98
cM capacity (veh/h)	1397				515	816

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	324	189	68
Volume Left	14	0	54
Volume Right	0	14	14
cSH	1397	1700	556
Volume to Capacity	0.01	0.11	0.12
Queue Length 95th (ft)	1	0	10
Control Delay (s)	0.4	0.0	12.4
Lane LOS	A		B
Approach Delay (s)	0.4	0.0	12.4
Approach LOS			B

Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	30.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)
34: 207th & Edgerton Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	40	150	0	0	120	20	0	5	0	80	5	30
Peak Hour Factor	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Hourly flow rate (vph)	61	227	0	0	182	30	0	8	0	121	8	45

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	288	212	8	174
Volume Left (vph)	61	0	0	121
Volume Right (vph)	0	30	0	45
Hadj (s)	0.93	0.71	0.34	0.08
Departure Headway (s)	5.7	5.6	6.0	5.4
Degree Utilization, x	0.45	0.33	0.01	0.26
Capacity (veh/h)	610	619	519	613
Control Delay (s)	13.3	11.3	9.1	10.3
Approach Delay (s)	13.3	11.3	9.1	10.3
Approach LOS	B	B	A	B

Intersection Summary			
Delay	11.9		
HCM Level of Service	B		
Intersection Capacity Utilization	40.8%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Wellsville North Alternative - (Mitigated) - AM Peak Hour

35: 207th & Evening Star Rd

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	5	0	150	5	0	190
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	10	0	300	10	0	380
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			10		620	10
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			10		620	10
tC, single (s)			4.6		6.4	6.7
tC, 2 stage (s)						
tF (s)			2.6		3.5	3.8
p0 queue free %			78		100	60
cM capacity (veh/h)			1370		355	940

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	10	310	380
Volume Left	0	300	0
Volume Right	0	0	380
cSH	1700	1370	940
Volume to Capacity	0.01	0.22	0.40
Queue Length 95th (ft)	0	21	49
Control Delay (s)	0.0	8.2	11.4
Lane LOS		A	B
Approach Delay (s)	0.0	8.2	11.4
Approach LOS			B

Intersection Summary			
Average Delay	9.8		
Intersection Capacity Utilization	33.7%	ICU Level of Service	A
Analysis Period (min)	15		

36: 215th & Evening Star Rd

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	5	5	180	150	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	10	10	360	300	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	370				200	190
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	370				200	190
tC, single (s)	4.1				6.8	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.9	3.3
p0 queue free %	100				57	99
cM capacity (veh/h)	1200				701	857

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	10	370	310
Volume Left	0	0	300
Volume Right	0	360	10
cSH	1200	1700	705
Volume to Capacity	0.00	0.22	0.44
Queue Length 95th (ft)	0	0	56
Control Delay (s)	0.0	0.0	14.1
Lane LOS			B
Approach Delay (s)	0.0	0.0	14.1
Approach LOS			B

Intersection Summary			
Average Delay	6.3		
Intersection Capacity Utilization	26.7%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Wellsville North Alternative - PM Peak Hour

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action
1: 175th Street & Waverly Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	100	5	5	320	90	10	20	5	40	20	20
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	24	120	6	6	386	108	12	24	6	48	24	24

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	151	500	42	96
Volume Left (vph)	24	6	12	48
Volume Right (vph)	6	108	6	24
Hadj (s)	0.08	-0.07	-0.03	-0.02
Departure Headway (s)	4.9	4.4	5.6	5.4
Degree Utilization, x	0.21	0.61	0.07	0.15
Capacity (veh/h)	683	793	558	586
Control Delay (s)	9.2	14.1	8.9	9.4
Approach Delay (s)	9.2	14.1	8.9	9.4
Approach LOS	A	B	A	A

Intersection Summary			
Delay	12.3		
HCM Level of Service	B		
Intersection Capacity Utilization	37.5%	ICU Level of Service	A
Analysis Period (min)	15		

2: US 56 & Gardner Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	310	60	250	720	250	70	170	160	160	170	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.98			0.97		1.00	0.93		1.00	0.97	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3294			3390		1787	1694		1736	1765	
Flt Permitted		0.77			0.74		0.51	1.00		0.32	1.00	
Satd. Flow (perm)		2534			2533		954	1694		593	1765	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	34	356	69	287	828	287	80	195	184	184	195	57
RTOR Reduction (vph)	0	16	0	0	25	0	0	38	0	0	12	0
Lane Group Flow (vph)	0	443	0	0	1377	0	80	342	0	184	240	0
Heavy Vehicles (%)	3%	8%	2%	1%	3%	1%	1%	4%	4%	4%	4%	4%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		50.8			50.8		27.5	27.5		27.5	27.5	
Effective Green, g (s)		50.8			50.8		27.5	27.5		27.5	27.5	
Actuated g/C Ratio		0.56			0.56		0.31	0.31		0.31	0.31	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1430			1430		292	518		181	539	
v/s Ratio Prot								0.20			0.14	
v/s Ratio Perm		0.17			c0.54		0.08			c0.31		
v/c Ratio		0.31			0.96		0.27	0.66		1.02	0.45	
Uniform Delay, d1		10.3			18.7		23.7	27.2		31.2	25.1	
Progression Factor		1.00			0.67		1.17	1.16		1.00	1.00	
Incremental Delay, d2		0.6			15.3		0.5	3.0		71.3	0.6	
Delay (s)		10.9			27.7		28.3	34.5		102.5	25.7	
Level of Service		B			C		C	C		F	C	
Approach Delay (s)		10.9			27.7			33.4			58.1	
Approach LOS		B			C			C			E	

Intersection Summary			
HCM Average Control Delay	30.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	11.7
Intersection Capacity Utilization	93.6%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

8: US-56 & I-35 SB Ramps — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1510	240	120	530	0	0	0	0	140	0	1380
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		0.98		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3462		1687	3725					1787		2787
Flt Permitted		1.00		0.95	1.00					0.95		1.00
Satd. Flow (perm)		3462		1687	3725					1787		2787
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1589	253	126	558	0	0	0	0	147	0	1453
RTOR Reduction (vph)	0	13	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	1829	0	126	558	0	0	0	0	147	0	1453
Heavy Vehicles (%)	0%	2%	3%	7%	2%	0%	0%	0%	0%	1%	0%	2%
Turn Type				Prot						Prot		custom
Protected Phases		2		1	6					7		5
Permitted Phases												4
Actuated Green, G (s)		61.1		12.6	23.3					11.3		50.4
Effective Green, g (s)		61.1		12.6	23.3					11.3		50.4
Actuated g/C Ratio		0.61		0.13	0.23					0.11		0.50
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2115		213	868					202		1405
v/s Ratio Prot		c0.53		0.07	c0.15					c0.08		c0.52
v/s Ratio Perm												
v/c Ratio		0.86		0.59	0.64					0.73		1.03
Uniform Delay, d1		16.0		41.3	34.6					42.9		24.8
Progression Factor		0.69		0.89	0.88					1.00		1.00
Incremental Delay, d2		3.6		3.9	3.3					12.3		33.3
Delay (s)		14.7		40.7	33.9					55.2		58.1
Level of Service		B		D	C					E		E
Approach Delay (s)		14.7			35.1			0.0			57.8	
Approach LOS		B			D			A			E	

Intersection Summary			
HCM Average Control Delay	34.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	75.5%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

9: US-56 & I-35 NB Ramps — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	530	0	0	560	20	90	0	40	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			1.00			0.96				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3762			1832			1576				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3762			1832			1576				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	602	0	0	636	23	102	0	45	0	0	0
RTOR Reduction (vph)	0	0	0	0	1	0	0	18	0	0	0	0
Lane Group Flow (vph)	0	602	0	0	658	0	0	129	0	0	0	0
Heavy Vehicles (%)	0%	1%	0%	0%	3%	10%	8%	0%	20%	0%	0%	0%
Turn Type							Perm					
Protected Phases		2			6			8				
Permitted Phases							8					
Actuated Green, G (s)		76.6			76.6			13.4				
Effective Green, g (s)		76.6			76.6			13.4				
Actuated g/C Ratio		0.77			0.77			0.13				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		2882			1403			211				
v/s Ratio Prot		0.16			c0.36							
v/s Ratio Perm								0.08				
v/c Ratio		0.21			0.47			0.61				
Uniform Delay, d1		3.3			4.3			40.8				
Progression Factor		0.72			1.00			1.00				
Incremental Delay, d2		0.1			1.1			5.1				
Delay (s)		2.5			5.4			46.0				
Level of Service		A			A			D				
Approach Delay (s)		2.5			5.4			46.0			0.0	
Approach LOS		A			A			D			A	

Intersection Summary			
HCM Average Control Delay	8.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	72.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

2015 Wellsville North Alternative - PM Peak Hour

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action
11: Waverly Road & US 56 — PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		+			+			+			+	
Volume (veh/h)	0	10	5	10	5	20	20	140	0	5	310	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	13	6	13	6	25	25	177	0	6	392	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	665	639	177	649	636	396	399			177		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	665	639	177	649	636	396	399			177		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	100	97	99	96	98	96	98			100		
cM capacity (veh/h)	350	386	871	353	388	647	1171			1411		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	19	44	203	405
Volume Left	0	13	25	6
Volume Right	6	25	0	6
cSH	474	485	1171	1411
Volume to Capacity	0.04	0.09	0.02	0.00
Queue Length 95th (ft)	3	7	2	0
Control Delay (s)	12.9	13.2	1.2	0.2
Lane LOS	B	B	A	A
Approach Delay (s)	12.9	13.2	1.2	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	34.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action
13: 183rd Street & US 56 — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		+			+			+			+	
Volume (veh/h)	5	5	0	10	10	0	0	170	20	0	320	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	6	0	13	13	0	0	215	25	0	405	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	639	646	405	636	633	228	405			241		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	639	646	405	636	633	228	405			241		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	100	97	97	100	100			100		
cM capacity (veh/h)	382	393	650	389	400	816	1165			1338		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	13	25	241	405
Volume Left	6	13	0	0
Volume Right	0	0	25	0
cSH	387	394	1165	1338
Volume to Capacity	0.03	0.06	0.00	0.00
Queue Length 95th (ft)	3	5	0	0
Control Delay (s)	14.6	14.8	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	14.6	14.8	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	26.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action
16: Four Corners Road & US 56 — PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		+			+			+			+	
Volume (veh/h)	5	5	5	0	5	5	5	180	5	5	330	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	7	7	7	0	7	7	7	237	7	7	434	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	711	701	240	711	704	434	434			243		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	711	701	240	711	704	434	434			243		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	100	98	99	99			100		
cM capacity (veh/h)	339	362	804	340	360	626	1136			1335		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	20	13	250	441
Volume Left	7	0	7	7
Volume Right	7	7	7	0
cSH	431	457	1136	1335
Volume to Capacity	0.05	0.03	0.01	0.00
Queue Length 95th (ft)	4	2	0	0
Control Delay (s)	13.7	13.1	0.3	0.2
Lane LOS	B	B	A	A
Approach Delay (s)	13.7	13.1	0.3	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	31.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action
17: 191st Street & US 56 — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		+			+			+			+	
Volume (veh/h)	0	0	0	5	5	0	0	180	0	0	330	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	0	0	0	6	6	0	0	234	0	0	429	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	669	666	432	666	669	234	435			234		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	669	666	432	666	669	234	435			234		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	98	98	100	100			100		
cM capacity (veh/h)	369	383	628	376	381	810	1135			1346		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	0	13	234	435
Volume Left	0	6	0	0
Volume Right	0	0	0	6
cSH	1700	379	1135	1346
Volume to Capacity	0.00	0.03	0.00	0.00
Queue Length 95th (ft)	0	3	0	0
Control Delay (s)	0.0	14.8	0.0	0.0
Lane LOS	A	B		
Approach Delay (s)	0.0	14.8	0.0	0.0
Approach LOS	A	B		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	27.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action

24: Sunflower Road & US 56

PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	5	10	40	5	0	10	190	40	0	380	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	6	13	51	6	0	13	241	51	0	481	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	778	801	484	791	778	266	487			291		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	778	801	484	791	778	266	487			291		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	100	98	98	82	98	100	99			100		
cM capacity (veh/h)	308	316	587	287	326	778	1086			1282		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	19	57	304	487
Volume Left	0	51	13	0
Volume Right	13	0	51	6
cSH	457	291	1086	1282
Volume to Capacity	0.04	0.20	0.01	0.00
Queue Length 95th (ft)	3	18	1	0
Control Delay (s)	13.2	20.4	0.5	0.0
Lane LOS	B	C	A	
Approach Delay (s)	13.2	20.4	0.5	0.0
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	36.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action

25: US 56 & 4th Street

PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	200	20	60	360	70	40
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	256	26	77	462	90	51
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			282		885	269
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			282		885	269
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			94		70	93
cM capacity (veh/h)			1292		298	774

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	282	538	141
Volume Left	0	77	90
Volume Right	26	0	51
cSH	1700	1292	384
Volume to Capacity	0.17	0.06	0.37
Queue Length 95th (ft)	0	5	41
Control Delay (s)	0.0	1.7	19.7
Lane LOS		A	C
Approach Delay (s)	0.0	1.7	19.7
Approach LOS			C

Intersection Summary			
Average Delay	3.8		
Intersection Capacity Utilization	50.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action

28: I-35 SB Ramps & Sunflower Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	70	0	460	10	30	0	0	240	30
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	0	0	0	80	0	529	11	34	0	0	276	34
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	879	351	293	351	368	34	310			34		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	879	351	293	351	368	34	310			34		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.4	4.2			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.5	2.3			2.2		
p0 queue free %	100	100	100	87	100	46	99			100		
cM capacity (veh/h)	124	572	751	602	559	982	1206			1590		

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	609	46	310
Volume Left	80	11	0
Volume Right	529	0	34
cSH	906	1206	1700
Volume to Capacity	0.67	0.01	0.18
Queue Length 95th (ft)	134	1	0
Control Delay (s)	16.7	2.1	0.0
Lane LOS	C	A	
Approach Delay (s)	16.7	2.1	0.0
Approach LOS	C		

Intersection Summary			
Average Delay	10.6		
Intersection Capacity Utilization	53.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action

29: I-35 NB Ramps & Sunflower Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	20	0	5	0	0	0	0	10	20	230	80	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	23	0	6	0	0	0	0	11	23	264	92	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	644	655	92	649	644	23	92			34		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	644	655	92	649	644	23	92			34		
tC, single (s)	7.3	6.5	6.2	7.1	6.5	6.2	4.1			4.5		
tC, 2 stage (s)												
tF (s)	3.7	4.0	3.3	3.5	4.0	3.3	2.2			2.5		
p0 queue free %	93	100	99	100	100	100	100			81		
cM capacity (veh/h)	309	314	971	327	318	1060	1515			1378		

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	29	34	356
Volume Left	23	0	264
Volume Right	6	23	0
cSH	357	1700	1378
Volume to Capacity	0.08	0.02	0.19
Queue Length 95th (ft)	7	0	18
Control Delay (s)	16.0	0.0	6.5
Lane LOS	C		A
Approach Delay (s)	16.0	0.0	6.5
Approach LOS	C		

Intersection Summary			
Average Delay	6.6		
Intersection Capacity Utilization	33.6%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Wellsville North Alternative - PM Peak Hour

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action

31: US 56 & Edgerton Rd

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	130	20	50	260	10	30	10	20	20	10	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	141	22	54	283	11	33	11	22	22	11	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	293			163			571	565	152	587	571	288
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	293			163			571	565	152	587	571	288
tC, single (s)	4.1			4.2			7.2	6.6	6.4	7.2	6.6	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.3			3.6	4.1	3.5	3.5	4.1	3.3
p0 queue free %	100			96			92	97	97	94	97	99
cM capacity (veh/h)	1280			1346			399	404	837	384	401	756

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	168	348	65	38
Volume Left	5	54	33	22
Volume Right	22	11	22	5
cSH	1280	1346	484	419
Volume to Capacity	0.00	0.04	0.13	0.09
Queue Length 95th (ft)	0	3	12	7
Control Delay (s)	0.3	1.5	13.6	14.5
Lane LOS	A	A	B	B
Approach Delay (s)	0.3	1.5	13.6	14.5
Approach LOS			B	B

Intersection Summary			
Average Delay	3.3		
Intersection Capacity Utilization	39.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action

32: 207th & Sunflower Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	0	140	5	5	5	220	170	5	5	180	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	0	177	6	6	6	278	215	6	6	228	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1028	1022	231	1196	1022	218	234			222		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1028	1022	231	1196	1022	218	234			222		
tC, single (s)	7.1	6.5	6.8	7.1	6.5	6.2	4.6			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.9	3.5	4.0	3.3	2.7			2.2		
p0 queue free %	96	100	74	94	96	99	75			100		
cM capacity (veh/h)	166	177	680	97	177	826	1096			1359		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	184	19	500	241
Volume Left	6	6	278	6
Volume Right	177	6	6	6
cSH	614	175	1096	1359
Volume to Capacity	0.30	0.11	0.25	0.00
Queue Length 95th (ft)	31	9	25	0
Control Delay (s)	13.3	28.1	6.4	0.2
Lane LOS	B	D	A	A
Approach Delay (s)	13.3	28.1	6.4	0.2
Approach LOS	B	D		

Intersection Summary			
Average Delay	6.6		
Intersection Capacity Utilization	50.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action

33: 207th & COOP Rd

PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	130	180	40	20	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	14	176	243	54	27	14
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	297				473	270
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	297				473	270
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				95	98
cM capacity (veh/h)	1276				539	773

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	189	297	41
Volume Left	14	0	27
Volume Right	0	54	14
cSH	1276	1700	599
Volume to Capacity	0.01	0.17	0.07
Queue Length 95th (ft)	1	0	5
Control Delay (s)	0.6	0.0	11.4
Lane LOS	A		B
Approach Delay (s)	0.6	0.0	11.4
Approach LOS			B

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	25.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action

34: 207th & Edgerton Rd

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	100	0	5	120	60	5	5	5	30	5	20
Peak Hour Factor	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Hourly flow rate (vph)	15	152	0	8	182	91	8	8	8	45	8	30

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	167	280	23	83
Volume Left (vph)	15	8	8	45
Volume Right (vph)	0	91	8	30
Hadj (s)	1.44	0.81	-0.13	0.17
Departure Headway (s)	6.0	5.3	5.2	5.4
Degree Utilization, x	0.28	0.41	0.03	0.12
Capacity (veh/h)	574	664	626	613
Control Delay (s)	11.3	11.9	8.3	9.1
Approach Delay (s)	11.3	11.9	8.3	9.1
Approach LOS	B	B	A	A

Intersection Summary			
Delay	11.1		
HCM Level of Service	B		
Intersection Capacity Utilization	23.0%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Wellsville North Alternative - PM Peak Hour

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action
35: 207th & Evening Star Rd — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	10	5	120	10	5	100
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	20	10	240	20	10	200
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			30		525	25
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			30		525	25
tC, single (s)			5.1		6.4	7.1
tC, 2 stage (s)						
tF (s)			3.1		3.5	4.1
p0 queue free %			79		98	76
cM capacity (veh/h)			1134		407	842

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	30	260	210
Volume Left	0	240	10
Volume Right	10	0	200
cSH	1700	1134	801
Volume to Capacity	0.02	0.21	0.26
Queue Length 95th (ft)	0	20	26
Control Delay (s)	0.0	8.5	11.1
Lane LOS		A	B
Approach Delay (s)	0.0	8.5	11.1
Approach LOS			B

Intersection Summary			
Average Delay	9.1		
Intersection Capacity Utilization	27.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action
36: 215th & Evening Star Rd — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	5	5	100	120	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	10	10	200	240	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	210				120	110
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	210				120	110
tC, single (s)	4.1				7.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				4.4	3.3
p0 queue free %	100				65	99
cM capacity (veh/h)	1367				690	949

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	10	210	250
Volume Left	0	0	240
Volume Right	0	200	10
cSH	1367	1700	698
Volume to Capacity	0.00	0.12	0.36
Queue Length 95th (ft)	0	0	41
Control Delay (s)	0.0	0.0	13.0
Lane LOS			B
Approach Delay (s)	0.0	0.0	13.0
Approach LOS			B

Intersection Summary			
Average Delay	6.9		
Intersection Capacity Utilization	20.1%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Wellsville North Alternative - (Mitigated) - PM Peak Hour

1: 175th Street & Waverly Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	20	100	5	5	320	90	10	20	5	40	20	20
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	24	120	6	6	386	108	12	24	6	48	24	24
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	494			127			660	678	123	642	627	440
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	494			127			660	678	123	642	627	440
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	98			100			96	93	99	86	94	96
cM capacity (veh/h)	1080			1472			341	367	933	357	392	622

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	151	500	42	96
Volume Left	24	6	12	48
Volume Right	6	108	6	24
cSH	1080	1472	392	410
Volume to Capacity	0.02	0.00	0.11	0.24
Queue Length 95th (ft)	2	0	9	23
Control Delay (s)	1.5	0.1	15.3	16.5
Lane LOS	A	A	C	C
Approach Delay (s)	1.5	0.1	15.3	16.5
Approach LOS			C	C

Intersection Summary			
Average Delay	3.2		
Intersection Capacity Utilization	37.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)

2: US 56 & Gardner Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	310	60	250	720	250	70	170	160	160	170	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.98			0.97		1.00	0.93		1.00	0.97	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3294			3390		1787	1694		1736	1765	
Flt Permitted		0.77			0.74		0.51	1.00		0.32	1.00	
Satd. Flow (perm)		2534			2533		954	1694		593	1765	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	34	356	69	287	828	287	80	195	184	184	195	57
RTOR Reduction (vph)	0	16	0	0	25	0	0	38	0	0	12	0
Lane Group Flow (vph)	0	443	0	0	1377	0	80	342	0	184	240	0
Heavy Vehicles (%)	3%	8%	2%	1%	3%	1%	1%	4%	4%	4%	4%	4%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		50.8			50.8		27.5	27.5		27.5	27.5	
Effective Green, g (s)		50.8			50.8		27.5	27.5		27.5	27.5	
Actuated g/C Ratio		0.56			0.56		0.31	0.31		0.31	0.31	
Clearance Time (s)		5.9			5.9		5.8	5.8		5.8	5.8	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1430			1430		292	518		181	539	
v/s Ratio Prot								0.20			0.14	
v/s Ratio Perm		0.17			c0.54		0.08			c0.31		
v/c Ratio		0.31			0.96		0.27	0.66		1.02	0.45	
Uniform Delay, d1		10.3			18.7		23.7	27.2		31.2	25.1	
Progression Factor		1.00			0.67		1.17	1.16		1.00	1.00	
Incremental Delay, d2		0.6			15.3		0.5	3.0		71.3	0.6	
Delay (s)		10.9			27.7		28.3	34.5		102.5	25.7	
Level of Service		B			C		C	C		F	C	
Approach Delay (s)		10.9			27.7			33.4			58.1	
Approach LOS		B			C			C			E	

Intersection Summary			
HCM Average Control Delay	30.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	11.7
Intersection Capacity Utilization	93.6%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)

8: US-56 & I-35 SB Ramps

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1510	240	120	530	0	0	0	0	140	0	1380
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		0.98		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3462		1687	3725					1787		2787
Flt Permitted		1.00		0.95	1.00					0.95		1.00
Satd. Flow (perm)		3462		1687	3725					1787		2787
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1589	253	126	558	0	0	0	0	147	0	1453
RTOR Reduction (vph)	0	13	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	1829	0	126	558	0	0	0	0	147	0	1453
Heavy Vehicles (%)	0%	2%	3%	7%	2%	0%	0%	0%	0%	1%	0%	2%
Turn Type				Prot						Prot		custom
Protected Phases		2		1	6					7		5
Permitted Phases												4
Actuated Green, G (s)		61.1		12.6	23.3					11.3		50.4
Effective Green, g (s)		61.1		12.6	23.3					11.3		50.4
Actuated g/C Ratio		0.61		0.13	0.23					0.11		0.50
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2115		213	868					202		1405
v/s Ratio Prot		c0.53		0.07	c0.15					c0.08		c0.52
v/s Ratio Perm												
v/c Ratio		0.86		0.59	0.64					0.73		1.03
Uniform Delay, d1		16.0		41.3	34.6					42.9		24.8
Progression Factor		0.69		0.89	0.88					1.00		1.00
Incremental Delay, d2		3.6		3.9	3.3					12.3		33.3
Delay (s)		14.7		40.7	33.9					55.2		58.1
Level of Service		B		D	C					E		E
Approach Delay (s)		14.7			35.1			0.0			57.8	
Approach LOS		B			D			A			E	

Intersection Summary			
HCM Average Control Delay	34.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	75.5%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)

9: US-56 & I-35 NB Ramps

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	530	0	0	560	20	90	0	40	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0				
Lane Util. Factor		0.95			1.00			1.00				
Frt		1.00			1.00			0.96				
Flt Protected		1.00			1.00			0.97				
Satd. Flow (prot)		3762			1832			1576				
Flt Permitted		1.00			1.00			0.97				
Satd. Flow (perm)		3762			1832			1576				
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	602	0	0	636	23	102	0	45	0	0	0
RTOR Reduction (vph)	0	0	0	0	1	0	0	18	0	0	0	0
Lane Group Flow (vph)	0	602	0	0	658	0	0	129	0	0	0	0
Heavy Vehicles (%)	0%	1%	0%	0%	3%	10%	8%	0%	20%	0%	0%	0%
Turn Type				Perm			Perm					
Protected Phases		2			6			8				
Permitted Phases				6			8					
Actuated Green, G (s)		76.6			76.6			13.4				
Effective Green, g (s)		76.6			76.6			13.4				
Actuated g/C Ratio		0.77			0.77			0.13				
Clearance Time (s)		5.0			5.0			5.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		2882			1403			211				
v/s Ratio Prot		0.16			c0.36							
v/s Ratio Perm								0.08				
v/c Ratio		0.21			0.47			0.61				
Uniform Delay, d1		3.3			4.3			40.8				
Progression Factor		0.72			1.00			1.00				
Incremental Delay, d2		0.1			1.1			5.1				
Delay (s)		2.5			5.4			46.0				
Level of Service		A			A			D				
Approach Delay (s)		2.5			5.4			46.0			0.0	
Approach LOS		A			A			D			A	

Intersection Summary			
HCM Average Control Delay	8.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	72.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

2015 Wellsville North Alternative - (Mitigated) - PM Peak Hour

11: Waverly Road & US 56

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✣			✣			✣			✣	
Volume (veh/h)	0	10	5	10	5	20	20	140	0	5	310	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	13	6	13	6	25	25	177	0	6	392	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	665	639	177	649	636	396	399			177		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	665	639	177	649	636	396	399			177		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	100	97	99	96	98	96	98			100		
cM capacity (veh/h)	350	386	871	353	388	647	1171			1411		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	19	44	203	405
Volume Left	0	13	25	6
Volume Right	6	25	0	6
cSH	474	485	1171	1411
Volume to Capacity	0.04	0.09	0.02	0.00
Queue Length 95th (ft)	3	7	2	0
Control Delay (s)	12.9	13.2	1.2	0.2
Lane LOS	B	B	A	A
Approach Delay (s)	12.9	13.2	1.2	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	34.7%	ICU Level of Service	A
Analysis Period (min)	15		

13: 183rd Street & US 56

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✣			✣			✣			✣	
Volume (veh/h)	5	5	0	10	10	0	0	170	20	0	320	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	6	0	13	13	0	0	215	25	0	405	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	639	646	405	636	633	228	405			241		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	639	646	405	636	633	228	405			241		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	100	97	97	100	100			100		
cM capacity (veh/h)	382	393	650	389	400	816	1165			1338		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	13	25	241	405
Volume Left	6	13	0	0
Volume Right	0	0	25	0
cSH	387	394	1165	1338
Volume to Capacity	0.03	0.06	0.00	0.00
Queue Length 95th (ft)	3	5	0	0
Control Delay (s)	14.6	14.8	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	14.6	14.8	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	26.8%	ICU Level of Service	A
Analysis Period (min)	15		

16: Four Corners Road & US 56

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✣			✣			✣			✣	
Volume (veh/h)	5	5	5	0	5	5	5	180	5	5	330	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Hourly flow rate (vph)	7	7	7	0	7	7	7	237	7	7	434	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	711	701	240	711	704	434	434			243		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	711	701	240	711	704	434	434			243		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	98	99	100	98	99	99			100		
cM capacity (veh/h)	339	362	804	340	360	626	1136			1335		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	20	13	250	441
Volume Left	7	0	7	7
Volume Right	7	7	7	0
cSH	431	457	1136	1335
Volume to Capacity	0.05	0.03	0.01	0.00
Queue Length 95th (ft)	4	2	0	0
Control Delay (s)	13.7	13.1	0.3	0.2
Lane LOS	B	B	A	A
Approach Delay (s)	13.7	13.1	0.3	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	31.5%	ICU Level of Service	A
Analysis Period (min)	15		

17: 191st Street & US 56

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✣			✣			✣			✣	
Volume (veh/h)	0	0	0	5	5	0	0	180	0	0	330	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Hourly flow rate (vph)	0	0	0	6	6	0	0	234	0	0	429	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	669	666	432	666	669	234	435			234		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	669	666	432	666	669	234	435			234		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	98	98	100	100			100		
cM capacity (veh/h)	369	383	628	376	381	810	1135			1346		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	0	13	234	435
Volume Left	0	6	0	0
Volume Right	0	0	0	6
cSH	1700	379	1135	1346
Volume to Capacity	0.00	0.03	0.00	0.00
Queue Length 95th (ft)	0	3	0	0
Control Delay (s)	0.0	14.8	0.0	0.0
Lane LOS	A	B		
Approach Delay (s)	0.0	14.8	0.0	0.0
Approach LOS	A	B		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	27.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)

24: Sunflower Road & US 56 — PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	0	5	10	40	5	0	10	190	40	0	380	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	6	13	51	6	0	13	241	51	0	481	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	778	801	484	791	778	266	487			291		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	778	801	484	791	778	266	487			291		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	100	98	98	82	98	100	99			100		
cM capacity (veh/h)	308	316	587	287	326	778	1086			1282		

Direction, Lane #	SE 1	NW 1	NE 1	SW 1
Volume Total	19	57	304	487
Volume Left	0	51	13	0
Volume Right	13	0	51	6
cSH	457	291	1086	1282
Volume to Capacity	0.04	0.20	0.01	0.00
Queue Length 95th (ft)	3	18	1	0
Control Delay (s)	13.2	20.4	0.5	0.0
Lane LOS	B	C	A	
Approach Delay (s)	13.2	20.4	0.5	0.0
Approach LOS	B	C		

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	36.6%	ICU Level of Service	A
Analysis Period (min)	15		

HDR Engineering, Inc. — 4/30/2008

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)

25: US 56 & 4th Street — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	200	20	60	360	70	40
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	256	26	77	462	90	51
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			282		885	269
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			282		885	269
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			94		70	93
cM capacity (veh/h)			1292		298	774

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	282	538	141
Volume Left	0	77	90
Volume Right	26	0	51
cSH	1700	1292	384
Volume to Capacity	0.17	0.06	0.37
Queue Length 95th (ft)	0	5	41
Control Delay (s)	0.0	1.7	19.7
Lane LOS		A	C
Approach Delay (s)	0.0	1.7	19.7
Approach LOS			C

Intersection Summary			
Average Delay	3.8		
Intersection Capacity Utilization	50.3%	ICU Level of Service	A
Analysis Period (min)	15		

HDR Engineering, Inc. — 4/30/2008

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)

28: I-35 SB Ramps & Sunflower Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	70	0	460	10	30	0	0	240	30
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	0	0	0	80	0	529	11	34	0	0	276	34
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								811				
pX, platoon unblocked												
vC, conflicting volume	879	351	293	351	368	34	310			34		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	879	351	293	351	368	34	310			34		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.4	4.2			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.5	2.3			2.2		
p0 queue free %	100	100	100	87	100	46	99			100		
cM capacity (veh/h)	124	572	751	602	559	982	1206			1590		

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	609	46	310
Volume Left	80	11	0
Volume Right	529	0	34
cSH	906	1206	1700
Volume to Capacity	0.67	0.01	0.18
Queue Length 95th (ft)	134	1	0
Control Delay (s)	16.7	2.1	0.0
Lane LOS	C	A	
Approach Delay (s)	16.7	2.1	0.0
Approach LOS	C		

Intersection Summary			
Average Delay	10.6		
Intersection Capacity Utilization	53.4%	ICU Level of Service	A
Analysis Period (min)	15		

HDR Engineering, Inc. — 4/30/2008

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)

29: I-35 NB Ramps & Sunflower Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	0	5	0	0	0	0	10	20	230	80	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.97						0.91			1.00	
Flt Protected		0.96						1.00			0.96	
Satd. Flow (prot)		1533						1619			1435	
Flt Permitted		0.96						1.00			0.76	
Satd. Flow (perm)		1533						1619			1135	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	23	0	6	0	0	0	0	11	23	264	92	0
RTOR Reduction (vph)	0	6	0	0	0	0	0	6	0	0	0	0
Lane Group Flow (vph)	0	23	0	0	0	0	0	28	0	0	356	0
Heavy Vehicles (%)	20%	0%	0%	0%	0%	0%	0%	10%	5%	37%	1%	0%
Turn Type	Perm									Perm		
Protected Phases		4						2			6	
Permitted Phases	4									6		
Actuated Green, G (s)		1.1						28.8			28.8	
Effective Green, g (s)		1.1						28.8			28.8	
Actuated g/C Ratio		0.03						0.72			0.72	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		42						1169			819	
v/s Ratio Prot								0.02				
v/s Ratio Perm		0.02									c0.31	
v/c Ratio		0.55						0.02			0.43	
Uniform Delay, d1		19.2						1.6			2.2	
Progression Factor		1.00						1.00			1.00	
Incremental Delay, d2		14.7						0.0			0.4	
Delay (s)		33.9						1.6			2.6	
Level of Service		C						A			A	
Approach Delay (s)		33.9			0.0			1.6			2.6	
Approach LOS		C			A			A			A	

Intersection Summary			
HCM Average Control Delay	4.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	39.9	Sum of lost time (s)	10.0
Intersection Capacity Utilization	35.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HDR Engineering, Inc. — 4/30/2008

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)

31: US 56 & Edgerton Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	130	20	50	260	10	30	10	20	20	10	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	141	22	54	283	11	33	11	22	22	11	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	293			163			571	565	152	587	571	288
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	293			163			571	565	152	587	571	288
tC, single (s)	4.1			4.2			7.2	6.6	6.4	7.2	6.6	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.3			3.6	4.1	3.5	3.5	4.1	3.3
p0 queue free %	100			96			92	97	97	94	97	99
cM capacity (veh/h)	1280			1346			399	404	837	384	401	756

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	168	348	65	38
Volume Left	5	54	33	22
Volume Right	22	11	22	5
cSH	1280	1346	484	419
Volume to Capacity	0.00	0.04	0.13	0.09
Queue Length 95th (ft)	0	3	12	7
Control Delay (s)	0.3	1.5	13.6	14.5
Lane LOS	A	A	B	B
Approach Delay (s)	0.3	1.5	13.6	14.5
Approach LOS			B	B

Intersection Summary			
Average Delay	3.3		
Intersection Capacity Utilization	39.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)

32: 207th & Sunflower Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	0	140	5	5	5	220	170	5	5	180	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	0	177	6	6	6	278	215	6	6	228	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1028	1022	231	1196	1022	218	234			222		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1028	1022	231	1196	1022	218	234			222		
tC, single (s)	7.1	6.5	6.8	7.1	6.5	6.2	4.6			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.9	3.5	4.0	3.3	2.7			2.2		
p0 queue free %	96	100	74	94	96	99	75			100		
cM capacity (veh/h)	166	177	680	97	177	826	1096			1359		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	184	19	500	241
Volume Left	6	6	278	6
Volume Right	177	6	6	6
cSH	614	175	1096	1359
Volume to Capacity	0.30	0.11	0.25	0.00
Queue Length 95th (ft)	31	9	25	0
Control Delay (s)	13.3	28.1	6.4	0.2
Lane LOS	B	D	A	A
Approach Delay (s)	13.3	28.1	6.4	0.2
Approach LOS	B	D		

Intersection Summary			
Average Delay	6.6		
Intersection Capacity Utilization	50.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)

33: 207th & COOP Rd — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	130	180	40	20	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	14	176	243	54	27	14
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	297				473	270
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	297				473	270
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				95	98
cM capacity (veh/h)	1276				539	773

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	189	297	41
Volume Left	14	0	27
Volume Right	0	54	14
cSH	1276	1700	599
Volume to Capacity	0.01	0.17	0.07
Queue Length 95th (ft)	1	0	5
Control Delay (s)	0.6	0.0	11.4
Lane LOS	A		B
Approach Delay (s)	0.6	0.0	11.4
Approach LOS			B

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	25.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)

34: 207th & Edgerton Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	100	0	5	120	60	5	5	5	30	5	20
Peak Hour Factor	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Hourly flow rate (vph)	15	152	0	8	182	91	8	8	8	45	8	30

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	167	280	23	83
Volume Left (vph)	15	8	8	45
Volume Right (vph)	0	91	8	30
Hadj (s)	1.44	0.81	-0.13	0.17
Departure Headway (s)	6.0	5.3	5.2	5.4
Degree Utilization, x	0.28	0.41	0.03	0.12
Capacity (veh/h)	574	664	626	613
Control Delay (s)	11.3	11.9	8.3	9.1
Approach Delay (s)	11.3	11.9	8.3	9.1
Approach LOS	B	B	A	A

Intersection Summary			
Delay	11.1		
HCM Level of Service	B		
Intersection Capacity Utilization	23.0%	ICU Level of Service	A
Analysis Period (min)	15		

2015 Wellsville North Alternative - (Mitigated) - PM Peak Hour

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)
35: 207th & Evening Star Rd — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	10	5	120	10	5	100
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	20	10	240	20	10	200
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			30		525	25
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			30		525	25
tC, single (s)			5.1		6.4	7.1
tC, 2 stage (s)						
tF (s)			3.1		3.5	4.1
p0 queue free %			79		98	76
cM capacity (veh/h)			1134		407	842

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	30	260	210
Volume Left	0	240	10
Volume Right	10	0	200
cSH	1700	1134	801
Volume to Capacity	0.02	0.21	0.26
Queue Length 95th (ft)	0	20	26
Control Delay (s)	0.0	8.5	11.1
Lane LOS		A	B
Approach Delay (s)	0.0	8.5	11.1
Approach LOS			B

Intersection Summary			
Average Delay	9.1		
Intersection Capacity Utilization	27.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2015 Wellsville Alternative Action - (Mitigated)
36: 215th & Evening Star Rd — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	5	5	100	120	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	10	10	200	240	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	210				120	110
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	210				120	110
tC, single (s)	4.1				7.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				4.4	3.3
p0 queue free %	100				65	99
cM capacity (veh/h)	1367				690	949

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	10	210	250
Volume Left	0	0	240
Volume Right	0	200	10
cSH	1367	1700	698
Volume to Capacity	0.00	0.12	0.36
Queue Length 95th (ft)	0	0	41
Control Delay (s)	0.0	0.0	13.0
Lane LOS			B
Approach Delay (s)	0.0	0.0	13.0
Approach LOS			B

Intersection Summary			
Average Delay	6.9		
Intersection Capacity Utilization	20.1%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Wellsville North No Action - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Wellsville No-Action

1: 175th Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	20	570	10	10	10	310	230	10	20	150	50
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.86		1.00	0.92		1.00	0.99		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1736	1678		1805	1850		1770	3486		1805	3324	
Flt Permitted	0.74	1.00		0.29	1.00		0.62	1.00		0.60	1.00	
Satd. Flow (perm)	1357	1678		551	1850		1154	3486		1131	3324	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	21	600	11	11	11	326	242	11	21	158	53
RTOR Reduction (vph)	0	508	0	0	9	0	0	2	0	0	20	0
Lane Group Flow (vph)	74	113	0	11	13	0	326	251	0	21	191	0
Heavy Vehicles (%)	4%	0%	2%	0%	0%	0%	2%	3%	0%	0%	4%	6%
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	13.8	13.8		13.8	13.8		66.2	59.2		54.5	52.5	
Effective Green, g (s)	13.8	13.8		13.8	13.8		66.2	59.2		54.5	52.5	
Actuated g/C Ratio	0.15	0.15		0.15	0.15		0.74	0.66		0.61	0.58	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	208	257		84	284		908	2293		700	1939	
v/s Ratio Prot		c0.07			0.01		c0.03	0.07		0.00	0.06	
v/s Ratio Perm	0.05			0.02			c0.23			0.02		
v/c Ratio	0.36	0.44		0.13	0.04		0.36	0.11		0.03	0.10	
Uniform Delay, d1	34.1	34.6		32.9	32.5		4.4	5.7		7.1	8.3	
Progression Factor	1.00	1.00		1.00	1.00		0.47	0.39		1.00	1.00	
Incremental Delay, d2	1.0	1.2		0.7	0.1		0.2	0.1		0.0	0.1	
Delay (s)	35.2	35.8		33.6	32.5		2.3	2.3		7.2	8.4	
Level of Service	D	D		C	C		A	A		A	A	
Approach Delay (s)		35.7			32.9			2.3			8.3	
Approach LOS		D			C			A			A	

Intersection Summary			
HCM Average Control Delay	19.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.37		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	69.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville No-Action

2: US 56 & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	130	780	60	180	430	220	80	1040	310	370	850	120
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3619	1583	1687	3551	1538	1752	3689	1553	3367	3444	
Flt Permitted	0.43	1.00	1.00	0.16	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	793	3619	1583	283	3551	1538	1752	3689	1553	3367	3444	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	821	63	189	453	232	84	1095	326	389	895	126
RTOR Reduction (vph)	0	0	42	0	0	167	0	0	120	0	12	0
Lane Group Flow (vph)	137	821	21	189	453	65	84	1095	206	389	1009	0
Heavy Vehicles (%)	2%	5%	2%	7%	7%	5%	3%	3%	4%	4%	3%	2%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			
Actuated Green, G (s)	30.8	24.3	24.3	32.4	25.1	25.1	6.2	29.7	29.7	12.0	35.5	
Effective Green, g (s)	30.8	24.3	24.3	32.4	25.1	25.1	6.2	29.7	29.7	12.0	35.5	
Actuated g/C Ratio	0.34	0.27	0.27	0.36	0.28	0.28	0.07	0.33	0.33	0.13	0.39	
Clearance Time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	342	977	427	216	990	429	121	1217	512	449	1358	
v/s Ratio Prot	0.03	0.23		c0.07	0.13		0.05	c0.30		c0.12	0.29	
v/s Ratio Perm	0.11		0.01	c0.24		0.04			0.13			
v/c Ratio	0.40	0.84	0.05	0.88	0.46	0.15	0.69	0.90	0.40	0.87	0.74	
Uniform Delay, d1	21.2	31.0	24.3	22.6	26.8	24.4	41.0	28.7	23.3	38.2	23.3	
Progression Factor	0.47	0.57	0.32	1.32	1.06	2.57	0.73	0.59	0.25	1.00	1.00	
Incremental Delay, d2	0.7	8.1	0.2	28.9	1.4	0.7	10.6	6.2	0.3	15.9	2.2	
Delay (s)	10.7	25.8	7.9	58.7	29.9	63.6	40.5	23.2	6.1	54.2	25.6	
Level of Service	B	C	A	E	C	E	D	C	A	D	C	
Approach Delay (s)		22.6			45.1			20.5			33.5	
Approach LOS		C			D			C			C	

Intersection Summary			
HCM Average Control Delay	29.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	13.3
Intersection Capacity Utilization	84.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville No-Action

8: US-56 & I-35 SB Ramps

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	2770	90	320	1440	0	0	0	0	210	0	1400
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		1.00		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3509		1719	3725					1736		2760
Flt Permitted		1.00		0.08	1.00					0.95		1.00
Satd. Flow (perm)		3509		142	3725					1736		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2916	95	337	1516	0	0	0	0	221	0	1474
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	3009	0	337	1516	0	0	0	0	221	0	1474
Heavy Vehicles (%)	0%	2%	14%	5%	2%	0%	0%	0%	0%	4%	0%	3%
Turn Type				pm+pt						custom		custom
Protected Phases		2		1	6					4		5
Permitted Phases				6						4		4
Actuated Green, G (s)		80.0		64.0	51.0					12.0		54.0
Effective Green, g (s)		80.0		64.0	51.0					12.0		54.0
Actuated g/C Ratio		0.67		0.53	0.42					0.10		0.45
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2339		247	1583					174		1357
v/s Ratio Prot		c0.86		0.15	0.41					0.13		c0.38
v/s Ratio Perm				c0.58								0.15
v/c Ratio		1.29		1.36	0.96					1.27		1.09
Uniform Delay, d1		20.0		50.2	33.5					54.0		33.0
Progression Factor		1.11		1.08	1.20					1.00		1.00
Incremental Delay, d2		129.9		180.7	10.4					158.8		51.4
Delay (s)		152.0		234.9	50.7					212.8		84.4
Level of Service		F		F	D					F		F
Approach Delay (s)		152.0			84.2			0.0			101.1	
Approach LOS		F			F			A			F	

Intersection Summary			
HCM Average Control Delay	119.7	HCM Level of Service	F
HCM Volume to Capacity ratio	1.32		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	120.5%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville No-Action

9: US-56 & I-35 NB Ramps

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1300	0	0	1600	550	170	0	720	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95	0.95			
Frt		1.00			1.00	0.85	1.00	0.85	0.85			
Flt Protected		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (prot)		3725			3539	1583	1687	1490	1490			
Flt Permitted		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (perm)		3725			3539	1583	1687	1490	1490			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1368	0	0	1684	579	179	0	758	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	108	0	21	21	0	0	0
Lane Group Flow (vph)	0	1368	0	0	1684	471	179	358	358	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	2%	7%	0%	3%	0%	0%	0%
Turn Type						Perm	Perm		Perm			
Protected Phases		2			6			8				
Permitted Phases						6	8		8			
Actuated Green, G (s)		74.2			74.2	74.2	35.8	35.8	35.8			
Effective Green, g (s)		74.2			74.2	74.2	35.8	35.8	35.8			
Actuated g/C Ratio		0.62			0.62	0.62	0.30	0.30	0.30			
Clearance Time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0	3.0			
Lane Grp Cap (vph)		2303			2188	979	503	445	445			
v/s Ratio Prot		0.37			c0.48			c0.24				
v/s Ratio Perm						0.30	0.11		0.24			
v/c Ratio		0.59			0.77	0.48	0.36	0.80	0.80			
Uniform Delay, d1		13.8			16.7	12.4	33.0	38.9	38.9			
Progression Factor		0.71			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2		0.1			1.7	0.4	0.4	10.1	10.1			
Delay (s)		10.0			18.4	12.8	33.5	49.0	49.0			
Level of Service		A			B	B	C	D	D			
Approach Delay (s)		10.0			16.9			46.0			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	20.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	106.7%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville No-Action
11: Waverly Road & US 56 — AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	110	10	560	110	50	80	190	0	10	90	360
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor		0.95	1.00	0.97	0.95		1.00	0.95		1.00	0.95	1.00
Frt		1.00	0.85	1.00	0.95		1.00	1.00		1.00	1.00	0.85
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)		3539	1615	3400	3312		1736	3406		1805	3059	1568
Flt Permitted		1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)		3539	1615	3400	3312		1736	3406		1805	3059	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	116	11	589	116	53	84	200	0	11	95	379
RTOR Reduction (vph)	0	0	10	0	33	0	0	0	0	0	0	242
Lane Group Flow (vph)	0	116	1	589	136	0	84	200	0	11	95	137
Heavy Vehicles (%)	0%	2%	0%	3%	2%	8%	4%	6%	0%	0%	18%	3%
Turn Type	Prot		Perm	Prot			Prot		Perm	Prot		Perm
Protected Phases	3	8		7	4		5	2		1	6	
Permitted Phases			8					2	2			6
Actuated Green, G (s)		8.3	8.3	20.7	34.0		8.5	39.5		1.5	32.5	32.5
Effective Green, g (s)		8.3	8.3	20.7	34.0		8.5	39.5		1.5	32.5	32.5
Actuated g/C Ratio		0.09	0.09	0.23	0.38		0.09	0.44		0.02	0.36	0.36
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)		326	149	782	1251		164	1495		30	1105	566
v/s Ratio Prot		c0.03		c0.17	0.04		c0.05	0.06		0.01	0.03	
v/s Ratio Perm			0.00									c0.09
v/c Ratio		0.36	0.01	0.75	0.11		0.51	0.13		0.37	0.09	0.24
Uniform Delay, d1		38.3	37.1	32.3	18.2		38.8	15.1		43.8	19.0	20.1
Progression Factor		1.01	1.03	0.94	0.84		0.85	0.77		1.32	0.56	0.99
Incremental Delay, d2		0.7	0.0	3.7	0.0		2.6	0.2		6.5	0.1	0.9
Delay (s)		39.6	38.2	34.1	15.3		35.4	11.7		64.3	10.8	20.8
Level of Service		D	D	C	B		D	B		E	B	C
Approach Delay (s)		39.4			29.9			18.7			19.8	
Approach LOS		D			C			B			B	

Intersection Summary			
HCM Average Control Delay	25.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	42.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville No-Action
13: 183rd Street & US 56 — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	20	20	5	20	20	5	0	250	20	5	110	30
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	21	5	21	21	5	0	263	21	5	116	32
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	432	426	132	432	432	274	147			284		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	432	426	132	432	432	274	147			284		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	96	96	99	96	96	99	100			100		
cM capacity (veh/h)	516	521	923	517	518	770	1447			1290		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	47	47	284	153
Volume Left	21	21	0	5
Volume Right	5	5	21	32
cSH	545	537	1447	1290
Volume to Capacity	0.09	0.09	0.00	0.00
Queue Length 95th (ft)	7	7	0	0
Control Delay (s)	12.2	12.4	0.0	0.3
Lane LOS	B	B		A
Approach Delay (s)	12.2	12.4	0.0	0.3
Approach LOS	B	B		

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	24.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action
16: Four Corners Road & US 56 — AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	110	70	0	140	50	30	190	0	60	80	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	116	74	0	147	53	32	200	0	63	84	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	600	474	200	605	474	84	84			200		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	600	474	200	605	474	84	84			200		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	75	91	100	68	95	98			95		
cM capacity (veh/h)	281	457	843	288	457	975	1506			1372		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	195	200	232	147
Volume Left	5	0	32	63
Volume Right	74	53	0	0
cSH	542	531	1506	1372
Volume to Capacity	0.36	0.38	0.02	0.05
Queue Length 95th (ft)	41	43	2	4
Control Delay (s)	15.3	15.8	1.2	3.5
Lane LOS	C	C	A	A
Approach Delay (s)	15.3	15.8	1.2	3.5
Approach LOS	C	C		

Intersection Summary			
Average Delay	9.0		
Intersection Capacity Utilization	39.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action
17: 191st Street & US 56 — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	20	10	5	5	10	5	0	200	10	0	70	60
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	11	5	5	11	5	0	211	11	0	74	63
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	332	326	105	332	353	216	137			221		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	332	326	105	332	353	216	137			221		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	98	99	99	98	99	100			100		
cM capacity (veh/h)	613	595	955	614	575	829	1460			1360		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	37	21	221	137
Volume Left	21	5	0	0
Volume Right	5	5	11	63
cSH	640	634	1460	1360
Volume to Capacity	0.06	0.03	0.00	0.00
Queue Length 95th (ft)	5	3	0	0
Control Delay (s)	11.0	10.9	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	11.0	10.9	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	21.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action
24: Sunflower Road & US 56 — AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	5	20	5	270	30	5	5	200	360	10	60	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.98			1.00			0.91			1.00	
Flt Protected		0.99			0.96			1.00			0.99	
Satd. Flow (prot)		1844			1779			1669			1635	
Flt Permitted		0.95			0.73			1.00			0.92	
Satd. Flow (perm)		1762			1353			1667			1523	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	5	21	5	284	32	5	5	211	379	11	63	0
RTOR Reduction (vph)	0	4	0	0	1	0	0	59	0	0	0	0
Lane Group Flow (vph)	0	27	0	0	320	0	0	536	0	0	74	0
Heavy Vehicles (%)	0%	0%	0%	2%	3%	0%	0%	6%	3%	0%	18%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		26.0			26.0			54.0			54.0	
Effective Green, g (s)		26.0			26.0			54.0			54.0	
Actuated g/C Ratio		0.29			0.29			0.60			0.60	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		509			391			1000			914	
v/s Ratio Prot												
v/s Ratio Perm		0.02			c0.24			c0.32			0.05	
v/c Ratio		0.05			0.82			0.54			0.08	
Uniform Delay, d1		23.1			29.8			10.6			7.6	
Progression Factor		1.00			0.69			0.99			1.18	
Incremental Delay, d2		0.0			11.6			1.8			0.2	
Delay (s)		23.2			32.0			12.3			9.1	
Level of Service		C			C			B			A	
Approach Delay (s)		23.2			32.0			12.3			9.1	
Approach LOS		C			C			B			A	

Intersection Summary			
HCM Average Control Delay	18.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	65.3%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville No-Action
25: US 56 & 4th Street — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	480	130	80	250	110	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0			5.0	5.0	
Lane Util. Factor	1.00			1.00	1.00	
Frt	0.97			1.00	0.94	
Flt Protected	1.00			0.99	0.97	
Satd. Flow (prot)	1778			1779	1672	
Flt Permitted	1.00			0.77	0.97	
Satd. Flow (perm)	1778			1379	1672	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	505	137	84	263	116	84
RTOR Reduction (vph)	9	0	0	0	32	0
Lane Group Flow (vph)	633	0	0	347	168	0
Heavy Vehicles (%)	4%	3%	4%	6%	5%	3%
Turn Type			Perm			
Protected Phases	4			8	2	
Permitted Phases			8			
Actuated Green, G (s)	65.9			65.9	14.1	
Effective Green, g (s)	65.9			65.9	14.1	
Actuated g/C Ratio	0.73			0.73	0.16	
Clearance Time (s)	5.0			5.0	5.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	1302			1010	262	
v/s Ratio Prot	c0.36				c0.10	
v/s Ratio Perm				0.25		
v/c Ratio	0.49			0.34	0.64	
Uniform Delay, d1	5.0			4.3	35.6	
Progression Factor	1.00			0.35	1.00	
Incremental Delay, d2	1.3			0.8	5.3	
Delay (s)	6.3			2.3	40.9	
Level of Service	A			A	D	
Approach Delay (s)	6.3			2.3	40.9	
Approach LOS	A			A	D	

Intersection Summary			
HCM Average Control Delay	11.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	74.2%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville No-Action
28: I-35 SB Ramps & Sunflower Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	20	0	150	10	180	0	0	580	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)					5.0			5.0			5.0	
Lane Util. Factor					1.00			1.00			1.00	
Frt					0.88			1.00			0.98	
Flt Protected					0.99			1.00			1.00	
Satd. Flow (prot)					1603			1777			1830	
Flt Permitted					0.99			0.97			1.00	
Satd. Flow (perm)					1603			1721			1830	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	21	0	158	11	189	0	0	611	84
RTOR Reduction (vph)	0	0	0	0	144	0	0	0	0	0	3	0
Lane Group Flow (vph)	0	0	0	0	35	0	0	200	0	0	692	0
Heavy Vehicles (%)	0%	0%	0%	10%	0%	3%	0%	7%	0%	0%	2%	3%
Turn Type				custom			Perm					
Protected Phases				6	6			8			4	
Permitted Phases				6			8					
Actuated Green, G (s)					8.1			71.9			71.9	
Effective Green, g (s)					8.1			71.9			71.9	
Actuated g/C Ratio					0.09			0.80			0.80	
Clearance Time (s)					5.0			5.0			5.0	
Vehicle Extension (s)					3.0			3.0			3.0	
Lane Grp Cap (vph)					144			1375			1462	
v/s Ratio Prot					c0.02						c0.38	
v/s Ratio Perm								0.12				
v/c Ratio					0.24			0.15			0.47	
Uniform Delay, d1					38.1			2.1			2.9	
Progression Factor					1.00			0.73			1.00	
Incremental Delay, d2					0.9			0.2			1.1	
Delay (s)					39.0			1.7			4.0	
Level of Service					D			A			A	
Approach Delay (s)		0.0			39.0			1.7			4.0	
Approach LOS		A			D			A			A	

Intersection Summary			
HCM Average Control Delay	9.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	54.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville No-Action
29: I-35 NB Ramps & Sunflower Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	150	0	10	0	0	0	0	40	110	570	40	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.99						0.90			1.00	
Flt Protected		0.96						1.00			0.96	
Satd. Flow (prot)		1704						1652			1773	
Flt Permitted		0.96						1.00			0.63	
Satd. Flow (perm)		1704						1652			1171	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	158	0	11	0	0	0	0	42	116	600	42	0
RTOR Reduction (vph)	0	3	0	0	0	0	0	30	0	0	0	0
Lane Group Flow (vph)	0	166	0	0	0	0	0	128	0	0	642	0
Heavy Vehicles (%)	6%	0%	0%	0%	0%	0%	0%	8%	2%	2%	8%	0%
Turn Type	Perm									Perm		
Protected Phases		2						8			4	
Permitted Phases	2									4		
Actuated Green, G (s)		13.3						66.7			66.7	
Effective Green, g (s)		13.3						66.7			66.7	
Actuated g/C Ratio		0.15						0.74			0.74	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		252						1224			868	
v/s Ratio Prot								0.08				
v/s Ratio Perm		0.10									c0.55	
v/c Ratio		0.66						0.10			0.74	
Uniform Delay, d1		36.2						3.3			6.7	
Progression Factor		1.00						1.00			0.69	
Incremental Delay, d2		6.4						0.2			5.1	
Delay (s)		42.6						3.4			9.7	
Level of Service		D						A			A	
Approach Delay (s)		42.6			0.0			3.4			9.7	
Approach LOS		D			A			A			A	

Intersection Summary			
HCM Average Control Delay	14.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

2030 Wellsville North No Action - AM Peak Hour - Synchro Intersection LOS

31: US 56 & Edgerton Rd

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	420	30	40	170	80	30	90	80	40	50	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Hourly flow rate (vph)	5	457	33	43	185	87	32	95	87	43	53	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	272			489			825	842	473	933	815	228
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	272			489			825	842	473	933	815	228
tC, single (s)	4.1			4.2			7.2	6.7	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.3			3.6	4.2	3.3	3.5	4.0	3.3
p0 queue free %	100			96			87	64	85	70	82	100
cM capacity (veh/h)	1303			1034			236	265	589	146	297	816

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	495	315	213	96
Volume Left	5	43	32	43
Volume Right	33	87	87	0
cSH	1303	1034	334	202
Volume to Capacity	0.00	0.04	0.64	0.47
Queue Length 95th (ft)	0	3	104	58
Control Delay (s)	0.1	1.6	33.1	37.9
Lane LOS	A	A	D	E
Approach Delay (s)	0.1	1.6	33.1	37.9
Approach LOS			D	E

Intersection Summary			
Average Delay	10.1		
Intersection Capacity Utilization	59.6%	ICU Level of Service	B
Analysis Period (min)	15		

32: 207th & Sunflower Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	230	5	0	10	130	260	0	5	290	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	0	291	6	0	13	165	329	0	6	367	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1051	1038	367	1329	1038	329	367			329		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1051	1038	367	1329	1038	329	367			329		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	57	91	100	98	86			99		
cM capacity (veh/h)	181	199	678	68	199	717	1180			1242		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	291	19	494	373
Volume Left	0	6	165	6
Volume Right	291	13	0	0
cSH	678	171	1180	1242
Volume to Capacity	0.43	0.11	0.14	0.01
Queue Length 95th (ft)	54	9	12	0
Control Delay (s)	14.2	28.7	3.8	0.2
Lane LOS	B	D	A	A
Approach Delay (s)	14.2	28.7	3.8	0.2
Approach LOS	B	D		

Intersection Summary			
Average Delay	5.7		
Intersection Capacity Utilization	60.7%	ICU Level of Service	B
Analysis Period (min)	15		

33: 207th & COOP Rd

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	20	160	120	10	60	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	27	216	162	14	81	14
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	176				439	169
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	176				439	169
tC, single (s)	4.1				6.4	6.3
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.4
p0 queue free %	98				86	98
cM capacity (veh/h)	1413				564	855

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	243	176	95
Volume Left	27	0	81
Volume Right	0	14	14
cSH	1413	1700	593
Volume to Capacity	0.02	0.10	0.16
Queue Length 95th (ft)	1	0	14
Control Delay (s)	1.0	0.0	12.2
Lane LOS	A		B
Approach Delay (s)	1.0	0.0	12.2
Approach LOS			B

Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	30.4%	ICU Level of Service	A
Analysis Period (min)	15		

34: 207th & Edgerton Rd

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	10	0	0	5	120	0	10	0	160	5	5
Peak Hour Factor	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Hourly flow rate (vph)	15	15	0	0	8	182	0	15	0	242	8	8

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	30	189	15	258
Volume Left (vph)	15	0	0	242
Volume Right (vph)	0	182	0	8
Hadj (s)	0.10	-0.37	0.34	0.22
Departure Headway (s)	4.9	4.2	5.1	4.6
Degree Utilization, x	0.04	0.22	0.02	0.33
Capacity (veh/h)	677	794	664	740
Control Delay (s)	8.1	8.5	8.2	9.9
Approach Delay (s)	8.1	8.5	8.2	9.9
Approach LOS	A	A	A	A

Intersection Summary			
Delay	9.2		
HCM Level of Service	A		
Intersection Capacity Utilization	32.2%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Wellsville North No Action - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Wellsville No-Action

35: 207th & Evening Star Rd

AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	10	0	5	10	0	10
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	20	0	10	20	0	20
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			20		60	20
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			20		60	20
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		100	98
cM capacity (veh/h)			1609		946	1064

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	20	30	20
Volume Left	0	10	0
Volume Right	0	0	20
cSH	1700	1609	1064
Volume to Capacity	0.01	0.01	0.02
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	2.4	8.4
Lane LOS		A	A
Approach Delay (s)	0.0	2.4	8.4
Approach LOS			A

Intersection Summary			
Average Delay	3.5		
Intersection Capacity Utilization	15.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action

36: 215th & Evening Star Rd

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	0	0	0	5	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	0	0	0	10	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	0				0	0
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	0				0	0
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	99
cM capacity (veh/h)	1636				1029	1091

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	0	0	20
Volume Left	0	0	10
Volume Right	0	0	10
cSH	1700	1700	1059
Volume to Capacity	0.00	0.00	0.02
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	0.0	8.5
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.5
Approach LOS			A

Intersection Summary			
Average Delay	8.5		
Intersection Capacity Utilization	6.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action

37: 199th Street & West Waverley

AM Peak Hour

Movement	EBL	EBT	WBU	WBT	WBR	SBL	SBR
Lane Configurations							
Volume (veh/h)	10	730	0	670	60	30	10
Sign Control		Free		Free		Stop	
Grade		0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	793	0	728	65	33	11
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type		TWLTL		TWLTL			
Median storage veh)		2		2			
Upstream signal (ft)				802			
pX, platoon unblocked	0.98		0.00			0.98	0.98
vC, conflicting volume	793		0			1576	761
vC1, stage 1 conf vol						761	
vC2, stage 2 conf vol						815	
vCu, unblocked vol	781		0			1577	748
tC, single (s)	4.1		0.0			6.4	6.2
tC, 2 stage (s)						5.4	
tF (s)	2.2		0.0			3.5	3.3
p0 queue free %	99		0			90	97
cM capacity (veh/h)	831		0			329	404

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	11	793	793	0	43
Volume Left	11	0	0	0	33
Volume Right	0	0	65	0	11
cSH	831	1700	1700	1700	345
Volume to Capacity	0.01	0.47	0.47	0.00	0.13
Queue Length 95th (ft)	1	0	0	0	11
Control Delay (s)	9.4	0.0	0.0	0.0	16.9
Lane LOS	A				C
Approach Delay (s)	0.1		0.0		16.9
Approach LOS					C

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	48.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action

38: 199th Street & IH-35 SB Ramp

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	700	60	50	280	0	0	0	0	10	0	460
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		1.00		1.00	1.00					1.00		1.00
Frt		0.99		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		1843		1770	1863					1805		1583
Flt Permitted		1.00		0.29	1.00					0.95		1.00
Satd. Flow (perm)		1843		549	1863					1805		1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	761	65	54	304	0	0	0	0	11	0	500
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	445
Lane Group Flow (vph)	0	824	0	54	304	0	0	0	0	11	0	55
Heavy Vehicles (%)	0%	2%	2%	2%	2%	0%	0%	0%	0%	0%	0%	2%
Turn Type				Perm						custom		custom
Protected Phases		4			8							
Permitted Phases				8						6		6
Actuated Green, G (s)		70.1		70.1	70.1					9.9		9.9
Effective Green, g (s)		70.1		70.1	70.1					9.9		9.9
Actuated g/C Ratio		0.78		0.78	0.78					0.11		0.11
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		1435		428	1451					199		174
v/s Ratio Prot		c0.45			0.16							
v/s Ratio Perm				0.10						0.01		c0.03
v/c Ratio		0.57		0.13	0.21					0.06		0.32
Uniform Delay, d1		4.0		2.4	2.6					35.9		36.9
Progression Factor		0.94		0.78	0.79					1.00		1.00
Incremental Delay, d2		1.6		0.6	0.3					0.1		1.0
Delay (s)		5.4		2.5	2.4					36.0		38.0
Level of Service		A		A	A					D		D
Approach Delay (s)		5.4			2.4			0.0			37.9	
Approach LOS		A			A			A			D	

Intersection Summary			
HCM Average Control Delay	14.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	63.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

2030 Wellsville North No Action - AM Peak Hour - Synchro Intersection LOS

39: 199th Street & IH-35 NB Ramp
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	580	130	0	0	160	20	170	0	90	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0		5.0			
Lane Util. Factor	1.00	1.00			1.00		1.00		1.00			
Frt	1.00	1.00			0.98		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1770	1863			1839		1770		1583			
Flt Permitted	0.55	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	1021	1863			1839		1770		1583			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	630	141	0	0	174	22	185	0	98	0	0	0
RTOR Reduction (vph)	0	0	0	0	4	0	0	0	82	0	0	0
Lane Group Flow (vph)	630	141	0	0	192	0	185	0	16	0	0	0
Heavy Vehicles (%)	2%	2%	0%	0%	2%	0%	2%	0%	2%	0%	0%	0%
Turn Type	pm+pt						custom		custom			
Protected Phases	7	4			8							
Permitted Phases	4						2		2			
Actuated Green, G (s)	65.7	65.7			39.9		14.3		14.3			
Effective Green, g (s)	65.7	65.7			39.9		14.3		14.3			
Actuated g/C Ratio	0.73	0.73			0.44		0.16		0.16			
Clearance Time (s)	5.0	5.0			5.0		5.0		5.0			
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Lane Grp Cap (vph)	918	1360			815		281		252			
v/s Ratio Prot	c0.16	0.08			0.10							
v/s Ratio Perm	c0.34						c0.10		0.01			
v/c Ratio	0.69	0.10			0.24		0.66		0.06			
Uniform Delay, d1	5.5	3.5			15.6		35.6		32.2			
Progression Factor	0.74	0.49			0.51		1.00		1.00			
Incremental Delay, d2	1.8	0.1			0.1		5.5		0.1			
Delay (s)	5.9	1.9			8.1		41.0		32.3			
Level of Service	A	A			A		D		C			
Approach Delay (s)		5.1			8.1			38.0			0.0	
Approach LOS		A			A			D			A	

Intersection Summary			
HCM Average Control Delay	13.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	63.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

40: 199th Street & East Waverley
AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	200	10	5	160	10	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	217	11	5	174	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	820					
pX, platoon unblocked						
vC, conflicting volume			228		408	223
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			228		408	223
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	99
cM capacity (veh/h)			1352		601	822

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	228	179	16
Volume Left	0	5	11
Volume Right	11	0	5
cSH	1700	1352	660
Volume to Capacity	0.13	0.00	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.3	10.6
Lane LOS		A	B
Approach Delay (s)	0.0	0.3	10.6
Approach LOS			B

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	22.5%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Wellsville North No Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

1: 175th Street & Waverly Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↱		↰	↑↱		↰	↑↑↱		↰	↑↑↱	
Volume (vph)	70	20	570	10	10	10	310	230	10	20	150	50
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.86		1.00	0.92		1.00	0.99		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1736	1678		1805	1850		1770	3486		1805	3324	
Flt Permitted	0.74	1.00		0.29	1.00		0.62	1.00		0.60	1.00	
Satd. Flow (perm)	1357	1678		551	1850		1154	3486		1131	3324	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	21	600	11	11	11	326	242	11	21	158	53
RTOR Reduction (vph)	0	508	0	0	9	0	0	2	0	0	20	0
Lane Group Flow (vph)	74	113	0	11	13	0	326	251	0	21	191	0
Heavy Vehicles (%)	4%	0%	2%	0%	0%	0%	2%	3%	0%	0%	4%	6%
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	13.8	13.8		13.8	13.8		66.2	59.2		54.5	52.5	
Effective Green, g (s)	13.8	13.8		13.8	13.8		66.2	59.2		54.5	52.5	
Actuated g/C Ratio	0.15	0.15		0.15	0.15		0.74	0.66		0.61	0.58	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	208	257		84	284		908	2293		700	1939	
v/s Ratio Prot		c0.07			0.01		c0.03	0.07		0.00	0.06	
v/s Ratio Perm	0.05			0.02			c0.23			0.02		
v/c Ratio	0.36	0.44		0.13	0.04		0.36	0.11		0.03	0.10	
Uniform Delay, d1	34.1	34.6		32.9	32.5		4.4	5.7		7.1	8.3	
Progression Factor	1.00	1.00		1.00	1.00		0.47	0.39		1.00	1.00	
Incremental Delay, d2	1.0	1.2		0.7	0.1		0.2	0.1		0.0	0.1	
Delay (s)	35.2	35.8		33.6	32.5		2.3	2.3		7.2	8.4	
Level of Service	D	D		C	C		A	A		A	A	
Approach Delay (s)		35.7			32.9			2.3			8.3	
Approach LOS		D			C			A			A	

Intersection Summary			
HCM Average Control Delay	19.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.37		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	69.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

2: US 56 & Gardner Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↑	↱	↰	↑↑	↱	↰↰	↑↑↱	
Volume (vph)	130	780	60	180	430	220	80	1040	310	370	850	120
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3619	1583	1687	3551	1538	1752	3689	1553	3367	3444	
Flt Permitted	0.43	1.00	1.00	0.16	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	793	3619	1583	283	3551	1538	1752	3689	1553	3367	3444	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	821	63	189	453	232	84	1095	326	389	895	126
RTOR Reduction (vph)	0	0	42	0	0	167	0	0	120	0	12	0
Lane Group Flow (vph)	137	821	21	189	453	65	84	1095	206	389	1009	0
Heavy Vehicles (%)	2%	5%	2%	7%	7%	5%	3%	3%	4%	4%	3%	2%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			
Actuated Green, G (s)	30.8	24.3	24.3	32.4	25.1	25.1	6.2	29.7	29.7	12.0	35.5	
Effective Green, g (s)	30.8	24.3	24.3	32.4	25.1	25.1	6.2	29.7	29.7	12.0	35.5	
Actuated g/C Ratio	0.34	0.27	0.27	0.36	0.28	0.28	0.07	0.33	0.33	0.13	0.39	
Clearance Time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	342	977	427	216	990	429	121	1217	512	449	1358	
v/s Ratio Prot	0.03	0.23		c0.07	0.13		0.05	c0.30		c0.12	0.29	
v/s Ratio Perm	0.11		0.01	c0.24		0.04			0.13			
v/c Ratio	0.40	0.84	0.05	0.88	0.46	0.15	0.69	0.90	0.40	0.87	0.74	
Uniform Delay, d1	21.2	31.0	24.3	22.6	26.8	24.4	41.0	28.7	23.3	38.2	23.3	
Progression Factor	0.47	0.57	0.31	1.32	1.06	2.57	0.73	0.58	0.22	1.00	1.00	
Incremental Delay, d2	0.7	8.1	0.2	28.9	1.4	0.7	10.6	6.2	0.3	15.9	2.2	
Delay (s)	10.6	25.7	7.8	58.7	29.9	63.6	40.5	22.9	5.3	54.2	25.6	
Level of Service	B	C	A	E	C	E	D	C	A	D	C	
Approach Delay (s)		22.6			45.1			20.1			33.5	
Approach LOS		C			D			C			C	

Intersection Summary			
HCM Average Control Delay	29.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	13.3
Intersection Capacity Utilization	84.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

8: US-56 & I-35 SB Ramps

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↱		↰	↑↑					↰		↱↱
Volume (vph)	0	2770	90	320	1440	0	0	0	0	210	0	1400
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		1.00		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3509		1719	3725					1736		2760
Flt Permitted		1.00		0.08	1.00					0.95		1.00
Satd. Flow (perm)		3509		142	3725					1736		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2916	95	337	1516	0	0	0	0	221	0	1474
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	3009	0	337	1516	0	0	0	0	221	0	1474
Heavy Vehicles (%)	0%	2%	14%	5%	2%	0%	0%	0%	0%	4%	0%	3%
Turn Type				pm+pt						custom		custom
Protected Phases		2		1	6					4		5
Permitted Phases				6						4		4
Actuated Green, G (s)		80.0		64.0	51.0					12.0		54.0
Effective Green, g (s)		80.0		64.0	51.0					12.0		54.0
Actuated g/C Ratio		0.67		0.53	0.42					0.10		0.45
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2339		247	1583					174		1357
v/s Ratio Prot		c0.86		0.15	0.41					0.13		c0.38
v/s Ratio Perm				c0.58								0.15
v/c Ratio		1.29		1.36	0.96					1.27		1.09
Uniform Delay, d1		20.0		50.2	33.5					54.0		33.0
Progression Factor		1.02		1.01	1.29					1.00		1.00
Incremental Delay, d2		129.9		180.3	10.2					158.8		51.4
Delay (s)		150.2		231.0	53.2					212.8		84.4
Level of Service		F		F	D					F		F
Approach Delay (s)		150.2			85.6			0.0			101.1	
Approach LOS		F			F			A			F	

Intersection Summary			
HCM Average Control Delay	119.3	HCM Level of Service	F
HCM Volume to Capacity ratio	1.32		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	120.5%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

9: US-56 & I-35 NB Ramps

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑			↑↑	↱	↰	↑↱	↱			
Volume (vph)	0	1300	0	0	1600	550	170	0	720	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95	0.95			
Frt		1.00			1.00	0.85	1.00	0.85	0.85			
Flt Protected		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (prot)		3725			3539	1583	1687	1490	1490			
Flt Permitted		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (perm)		3725			3539	1583	1687	1490	1490			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1368	0	0	1684	579	179	0	758	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	112	0	0	0	0	0	0
Lane Group Flow (vph)	0	1368	0	0	1684	467	179	379	379	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	2%	7%	0%	3%	0%	0%	0%
Turn Type						Perm	Perm		Perm			
Protected Phases		2			6			8				
Permitted Phases						6	8		8			
Actuated Green, G (s)		72.6			72.6	72.6	37.4	37.4	37.4			
Effective Green, g (s)		72.6			72.6	72.6	37.4	37.4	37.4			
Actuated g/C Ratio		0.60			0.60	0.60	0.31	0.31	0.31			
Clearance Time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0	3.0			
Lane Grp Cap (vph)		2254			2141	958	526	464	464			
v/s Ratio Prot		0.37			c0.48			c0.25				
v/s Ratio Perm						0.29	0.11		0.25			
v/c Ratio		0.61			0.79	0.49	0.34	0.82	0.82			
Uniform Delay, d1		14.8			17.9	13.3	31.8	38.1	38.1			
Progression Factor		0.57			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2		0.1			2.0	0.4	0.4	10.7	10.7			
Delay (s)		8.6			19.8	13.7	32.2	48.8	48.8			
Level of Service		A			B	B	C	D	D			
Approach Delay (s)		8.6			18.3			45.6			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	21.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	106.7%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

2030 Wellsville No-Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study | 2030 Wellsville No-Action - (Improved)
11: Waverly Road & US 56 | AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	110	10	560	110	50	80	190	0	10	90	360
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor		0.95	1.00	0.97	0.95		1.00	0.95		1.00	0.95	1.00
Frt		1.00	0.85	1.00	0.95		1.00	1.00		1.00	1.00	0.85
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)		3539	1615	3400	3312		1736	3406		1805	3059	1568
Flt Permitted		1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)		3539	1615	3400	3312		1736	3406		1805	3059	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	116	11	589	116	53	84	200	0	11	95	379
RTOR Reduction (vph)	0	0	10	0	33	0	0	0	0	0	0	242
Lane Group Flow (vph)	0	116	1	589	136	0	84	200	0	11	95	137
Heavy Vehicles (%)	0%	2%	0%	3%	2%	8%	4%	6%	0%	0%	18%	3%
Turn Type	Prot		Perm	Prot			Prot		Perm	Prot		Perm
Protected Phases	3	8		7	4		5	2		1	6	
Permitted Phases			8					2	2			6
Actuated Green, G (s)		8.3	8.3	20.7	34.0		8.5	39.5		1.5	32.5	32.5
Effective Green, g (s)		8.3	8.3	20.7	34.0		8.5	39.5		1.5	32.5	32.5
Actuated g/C Ratio		0.09	0.09	0.23	0.38		0.09	0.44		0.02	0.36	0.36
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)		326	149	782	1251		164	1495		30	1105	566
v/s Ratio Prot		c0.03		c0.17	0.04		c0.05	0.06		0.01	0.03	
v/s Ratio Perm			0.00									c0.09
v/c Ratio		0.36	0.01	0.75	0.11		0.51	0.13		0.37	0.09	0.24
Uniform Delay, d1		38.3	37.1	32.3	18.2		38.8	15.1		43.8	19.0	20.1
Progression Factor		1.01	1.03	0.94	0.84		0.90	0.74		1.32	0.56	0.99
Incremental Delay, d2		0.7	0.0	3.7	0.0		2.6	0.2		6.5	0.1	0.9
Delay (s)		39.6	38.2	34.1	15.3		37.4	11.4		64.3	10.8	20.8
Level of Service		D	D	C	B		D	B		E	B	C
Approach Delay (s)		39.4			29.9			19.1			19.8	
Approach LOS		D			C			B			B	

Intersection Summary			
HCM Average Control Delay	25.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	42.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study | 2030 Wellsville No-Action - (Improved)
13: 183rd Street & US 56 | AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	20	20	5	20	20	5	0	250	20	5	110	30
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	21	5	21	21	5	0	263	21	5	116	32
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	432	426	132	432	432	274	147			284		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	432	426	132	432	432	274	147			284		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	96	96	99	96	96	99	100			100		
cM capacity (veh/h)	516	521	923	517	518	770	1447			1290		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	47	47	284	153
Volume Left	21	21	0	5
Volume Right	5	5	21	32
cSH	545	537	1447	1290
Volume to Capacity	0.09	0.09	0.00	0.00
Queue Length 95th (ft)	7	7	0	0
Control Delay (s)	12.2	12.4	0.0	0.3
Lane LOS	B	B		A
Approach Delay (s)	12.2	12.4	0.0	0.3
Approach LOS	B	B		

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	24.4%	ICU Level of Service	A
Analysis Period (min)	15		

HDR Engineering, Inc. 4/30/2008

BNSF NEPA Traffic Study | 2030 Wellsville No-Action - (Improved)
16: Four Corners Road & US 56 | AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	110	70	0	140	50	30	190	0	60	80	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	116	74	0	147	53	32	200	0	63	84	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	600	474	200	605	474	84	84			200		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	600	474	200	605	474	84	84			200		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	75	91	100	68	95	98			95		
cM capacity (veh/h)	281	457	843	288	457	975	1506			1372		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	195	200	232	147
Volume Left	5	0	32	63
Volume Right	74	53	0	0
cSH	542	531	1506	1372
Volume to Capacity	0.36	0.38	0.02	0.05
Queue Length 95th (ft)	41	43	2	4
Control Delay (s)	15.3	15.8	1.2	3.5
Lane LOS	C	C	A	A
Approach Delay (s)	15.3	15.8	1.2	3.5
Approach LOS	C	C		

Intersection Summary			
Average Delay	9.0		
Intersection Capacity Utilization	39.1%	ICU Level of Service	A
Analysis Period (min)	15		

HDR Engineering, Inc. 4/30/2008

BNSF NEPA Traffic Study | 2030 Wellsville No-Action - (Improved)
17: 191st Street & US 56 | AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	20	10	5	5	10	5	0	200	10	0	70	60
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	11	5	5	11	5	0	211	11	0	74	63
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	332	326	105	332	353	216	137			221		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	332	326	105	332	353	216	137			221		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	98	99	99	98	99	100			100		
cM capacity (veh/h)	613	595	955	614	575	829	1460			1360		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	37	21	221	137
Volume Left	21	5	0	0
Volume Right	5	5	11	63
cSH	640	634	1460	1360
Volume to Capacity	0.06	0.03	0.00	0.00
Queue Length 95th (ft)	5	3	0	0
Control Delay (s)	11.0	10.9	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	11.0	10.9	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	21.8%	ICU Level of Service	A
Analysis Period (min)	15		

HDR Engineering, Inc. 4/30/2008

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)
24: Sunflower Road & US 56 — AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	5	20	5	270	30	5	5	200	360	10	60	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.98			1.00			0.91			1.00	
Flt Protected		0.99			0.96			1.00			0.99	
Satd. Flow (prot)		1844			1779			1669			1635	
Flt Permitted		0.95			0.73			1.00			0.92	
Satd. Flow (perm)		1762			1353			1667			1523	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	5	21	5	284	32	5	5	211	379	11	63	0
RTOR Reduction (vph)	0	4	0	0	1	0	0	59	0	0	0	0
Lane Group Flow (vph)	0	27	0	0	320	0	0	536	0	0	74	0
Heavy Vehicles (%)	0%	0%	0%	2%	3%	0%	0%	6%	3%	0%	18%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		26.0			26.0			54.0			54.0	
Effective Green, g (s)		26.0			26.0			54.0			54.0	
Actuated g/C Ratio		0.29			0.29			0.60			0.60	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		509			391			1000			914	
v/s Ratio Prot												
v/s Ratio Perm		0.02			c0.24			c0.32			0.05	
v/c Ratio		0.05			0.82			0.54			0.08	
Uniform Delay, d1		23.1			29.8			10.6			7.6	
Progression Factor		1.00			0.99			0.64			1.18	
Incremental Delay, d2		0.0			10.5			1.8			0.2	
Delay (s)		23.2			40.1			8.6			9.1	
Level of Service		C			D			A			A	
Approach Delay (s)		23.2			40.1			8.6			9.1	
Approach LOS		C			D			A			A	

Intersection Summary			
HCM Average Control Delay	19.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	65.3%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)
25: US 56 & 4th Street — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	480	130	80	250	110	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0			5.0	5.0	
Lane Util. Factor	1.00			1.00	1.00	
Frt	0.97			1.00	0.94	
Flt Protected	1.00			0.99	0.97	
Satd. Flow (prot)	1778			1779	1672	
Flt Permitted	1.00			0.77	0.97	
Satd. Flow (perm)	1778			1379	1672	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	505	137	84	263	116	84
RTOR Reduction (vph)	8	0	0	0	33	0
Lane Group Flow (vph)	634	0	0	347	167	0
Heavy Vehicles (%)	4%	3%	4%	6%	5%	3%
Turn Type			Perm			
Protected Phases	4			8	2	
Permitted Phases			8			
Actuated Green, G (s)	65.9			65.9	14.1	
Effective Green, g (s)	65.9			65.9	14.1	
Actuated g/C Ratio	0.73			0.73	0.16	
Clearance Time (s)	5.0			5.0	5.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	1302			1010	262	
v/s Ratio Prot	c0.36				c0.10	
v/s Ratio Perm				0.25		
v/c Ratio	0.49			0.34	0.64	
Uniform Delay, d1	5.0			4.3	35.6	
Progression Factor	1.00			0.37	1.00	
Incremental Delay, d2	1.3			0.8	5.0	
Delay (s)	6.3			2.4	40.6	
Level of Service	A			A	D	
Approach Delay (s)	6.3			2.4	40.6	
Approach LOS	A			A	D	

Intersection Summary			
HCM Average Control Delay	10.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	74.2%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)
28: I-35 SB Ramps & Sunflower Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	20	0	150	10	180	0	0	580	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)					5.0			5.0			5.0	
Lane Util. Factor					1.00			1.00			1.00	
Frt					0.88			1.00			0.98	
Flt Protected					0.99			1.00			1.00	
Satd. Flow (prot)					1603			1777			1830	
Flt Permitted					0.99			0.97			1.00	
Satd. Flow (perm)					1603			1721			1830	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	21	0	158	11	189	0	0	611	84
RTOR Reduction (vph)	0	0	0	0	144	0	0	0	0	0	3	0
Lane Group Flow (vph)	0	0	0	0	35	0	0	200	0	0	692	0
Heavy Vehicles (%)	0%	0%	0%	10%	0%	3%	0%	7%	0%	0%	2%	3%
Turn Type				custom			Perm					
Protected Phases				6	6			8			4	
Permitted Phases				6			8					
Actuated Green, G (s)					8.1			71.9			71.9	
Effective Green, g (s)					8.1			71.9			71.9	
Actuated g/C Ratio					0.09			0.80			0.80	
Clearance Time (s)					5.0			5.0			5.0	
Vehicle Extension (s)					3.0			3.0			3.0	
Lane Grp Cap (vph)					144			1375			1462	
v/s Ratio Prot					c0.02						c0.38	
v/s Ratio Perm								0.12				
v/c Ratio					0.24			0.15			0.47	
Uniform Delay, d1					38.1			2.1			2.9	
Progression Factor					1.00			0.73			1.00	
Incremental Delay, d2					0.9			0.2			1.1	
Delay (s)					39.0			1.7			4.0	
Level of Service					D			A			A	
Approach Delay (s)		0.0			39.0			1.7			4.0	
Approach LOS		A			D			A			A	

Intersection Summary			
HCM Average Control Delay	9.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	54.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)
29: I-35 NB Ramps & Sunflower Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	150	0	10	0	0	0	0	40	110	570	40	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.99						0.90			1.00	
Flt Protected		0.96						1.00			0.96	
Satd. Flow (prot)		1704						1652			1773	
Flt Permitted		0.96						1.00			0.63	
Satd. Flow (perm)		1704						1652			1171	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	158	0	11	0	0	0	0	42	116	600	42	0
RTOR Reduction (vph)	0	3	0	0	0	0	0	30	0	0	0	0
Lane Group Flow (vph)	0	166	0	0	0	0	0	128	0	0	642	0
Heavy Vehicles (%)	6%	0%	0%	0%	0%	0%	0%	8%	2%	2%	8%	0%
Turn Type	Perm									Perm		
Protected Phases		2						8			4	
Permitted Phases	2									4		
Actuated Green, G (s)		13.3						66.7			66.7	
Effective Green, g (s)		13.3						66.7			66.7	
Actuated g/C Ratio		0.15						0.74			0.74	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		252						1224			868	
v/s Ratio Prot								0.08				
v/s Ratio Perm		0.10									c0.55	
v/c Ratio		0.66						0.10			0.74	
Uniform Delay, d1		36.2						3.3			6.7	
Progression Factor		1.00						1.00			0.69	
Incremental Delay, d2		6.4						0.2			5.1	
Delay (s)		42.6						3.4			9.7	
Level of Service		D						A			A	
Approach Delay (s)		42.6			0.0			3.4			9.7	
Approach LOS		D			A			A			A	

Intersection Summary			
HCM Average Control Delay	14.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

2030 Wellsville No-Action - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)
31: US 56 & Edgerton Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	420	30	40	170	80	30	90	80	40	50	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Hourly flow rate (vph)	5	457	33	43	185	87	32	95	87	43	53	0

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	495	315	213	96
Volume Left (vph)	5	43	32	43
Volume Right (vph)	33	87	87	0
Hadj (s)	0.01	-0.04	0.01	0.13
Departure Headway (s)	5.5	5.8	6.4	6.9
Degree Utilization, x	0.76	0.51	0.38	0.18
Capacity (veh/h)	631	579	497	449
Control Delay (s)	23.9	14.5	13.3	11.4
Approach Delay (s)	23.9	14.5	13.3	11.4
Approach LOS	C	B	B	B

Intersection Summary			
Delay	18.2		
HCM Level of Service	C		
Intersection Capacity Utilization	59.6%	ICU Level of Service	B
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)
32: 207th & Sunflower Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	230	5	0	10	130	260	0	5	290	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	0	0	291	6	0	13	165	329	0	6	367	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1051	1038	367	1329	1038	329	367			329		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1051	1038	367	1329	1038	329	367			329		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	57	91	100	98	86			99		
cM capacity (veh/h)	181	199	678	68	199	717	1180			1242		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	291	19	494	373
Volume Left	0	6	165	6
Volume Right	291	13	0	0
cSH	678	171	1180	1242
Volume to Capacity	0.43	0.11	0.14	0.01
Queue Length 95th (ft)	54	9	12	0
Control Delay (s)	14.2	28.7	3.8	0.2
Lane LOS	B	D	A	A
Approach Delay (s)	14.2	28.7	3.8	0.2
Approach LOS	B	D		

Intersection Summary			
Average Delay	5.7		
Intersection Capacity Utilization	60.7%	ICU Level of Service	B
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)
33: 207th & COOP Rd — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	20	160	120	10	60	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	27	216	162	14	81	14
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	176				439	169
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	176				439	169
tC, single (s)	4.1				6.4	6.5
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.6
p0 queue free %	98				86	98
cM capacity (veh/h)	1413				564	807

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	243	176	95
Volume Left	27	0	81
Volume Right	0	14	14
cSH	1413	1700	589
Volume to Capacity	0.02	0.10	0.16
Queue Length 95th (ft)	1	0	14
Control Delay (s)	1.0	0.0	12.3
Lane LOS	A		B
Approach Delay (s)	1.0	0.0	12.3
Approach LOS			B

Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	30.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)
34: 207th & Edgerton Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	10	0	0	5	120	0	10	0	160	5	5
Peak Hour Factor	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Hourly flow rate (vph)	15	15	0	0	8	182	0	15	0	242	8	8

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	30	189	15	258
Volume Left (vph)	15	0	0	242
Volume Right (vph)	0	182	0	8
Hadj (s)	0.10	-0.37	0.34	0.22
Departure Headway (s)	4.9	4.2	5.1	4.6
Degree Utilization, x	0.04	0.22	0.02	0.33
Capacity (veh/h)	677	794	664	740
Control Delay (s)	8.1	8.5	8.2	9.9
Approach Delay (s)	8.1	8.5	8.2	9.9
Approach LOS	A	A	A	A

Intersection Summary			
Delay	9.2		
HCM Level of Service	A		
Intersection Capacity Utilization	32.2%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)
35: 207th & Evening Star Rd — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	10	0	5	10	0	10
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	20	0	10	20	0	20
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			20		60	20
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			20		60	20
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		100	98
cM capacity (veh/h)			1609		946	1064

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	20	30	20
Volume Left	0	10	0
Volume Right	0	0	20
cSH	1700	1609	1064
Volume to Capacity	0.01	0.01	0.02
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	2.4	8.4
Lane LOS		A	A
Approach Delay (s)	0.0	2.4	8.4
Approach LOS			A

Intersection Summary			
Average Delay	3.5		
Intersection Capacity Utilization	15.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)
36: 215th & Evening Star Rd — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	0	0	0	5	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	0	0	0	10	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	0				0	0
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	0				0	0
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	99
cM capacity (veh/h)	1636				1029	1091

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	0	0	20
Volume Left	0	0	10
Volume Right	0	0	10
cSH	1700	1700	1059
Volume to Capacity	0.00	0.00	0.02
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	0.0	8.5
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.5
Approach LOS			A

Intersection Summary			
Average Delay	8.5		
Intersection Capacity Utilization	6.7%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)
37: 199th Street & West Waverley — AM Peak Hour

Movement	EBL	EBT	WBU	WBT	WBR	SBL	SBR
Lane Configurations							
Volume (veh/h)	10	730	0	670	60	30	10
Sign Control		Free		Free		Stop	
Grade		0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	793	0	728	65	33	11
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type		TWLTL		TWLTL			
Median storage veh)		2		2			
Upstream signal (ft)				802			
pX, platoon unblocked			0.00				
vC, conflicting volume	793		0			1576	761
vC1, stage 1 conf vol						761	
vC2, stage 2 conf vol						815	
vCu, unblocked vol	793		0			1576	761
tC, single (s)	4.1		0.0			6.4	6.2
tC, 2 stage (s)						5.4	
tF (s)	2.2		0.0			3.5	3.3
p0 queue free %	99		0			90	97
cM capacity (veh/h)	836		0			331	404

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	11	793	793	0	43
Volume Left	11	0	0	0	33
Volume Right	0	0	65	0	11
cSH	836	1700	1700	1700	346
Volume to Capacity	0.01	0.47	0.47	0.00	0.13
Queue Length 95th (ft)	1	0	0	0	11
Control Delay (s)	9.4	0.0	0.0	0.0	16.9
Lane LOS	A				C
Approach Delay (s)	0.1		0.0		16.9
Approach LOS					C

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	48.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)
38: 199th Street & IH-35 SB Ramp — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	700	60	50	280	0	0	0	0	10	0	460
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		2.5		2.5	2.5					2.5		2.5
Lane Util. Factor		1.00		1.00	1.00					1.00		1.00
Frt		0.99		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		1843		1770	1863					1805		1583
Flt Permitted		1.00		0.27	1.00					0.95		1.00
Satd. Flow (perm)		1843		509	1863					1805		1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	761	65	54	304	0	0	0	0	11	0	500
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	459
Lane Group Flow (vph)	0	824	0	54	304	0	0	0	0	11	0	41
Heavy Vehicles (%)	0%	2%	2%	2%	2%	0%	0%	0%	0%	0%	0%	2%
Turn Type				pm+pt						Prot		custom
Protected Phases		4		3	8					1		
Permitted Phases				8								1
Actuated Green, G (s)		70.3		77.6	77.6					7.4		7.4
Effective Green, g (s)		70.3		77.6	77.6					7.4		7.4
Actuated g/C Ratio		0.78		0.86	0.86					0.08		0.08
Clearance Time (s)		2.5		2.5	2.5					2.5		2.5
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		1440		506	1606					148		130
v/s Ratio Prot		c0.45		0.01	c0.16					0.01		
v/s Ratio Perm				0.09								c0.03
v/c Ratio		0.57		0.11	0.19					0.07		0.32
Uniform Delay, d1		3.9		2.6	1.0					38.1		38.9
Progression Factor		1.80		0.29	0.63					1.00		1.00
Incremental Delay, d2		1.6		0.1	0.1					0.2		1.4
Delay (s)		8.6		0.8	0.7					38.4		40.3
Level of Service		A		A	A					D		D
Approach Delay (s)		8.6			0.7			0.0			40.3	
Approach LOS		A			A			A			D	

Intersection Summary			
HCM Average Control Delay	16.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	7.5
Intersection Capacity Utilization	63.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)
39: 199th Street & IH-35 NB Ramp — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	580	130	0	0	160	20	170	0	90	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0		5.0			
Lane Util. Factor	1.00	1.00			1.00		1.00		1.00			
Frt	1.00	1.00			0.98		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1770	1863			1839		1770		1583			
Flt Permitted	0.56	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	1046	1863			1839		1770		1583			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	630	141	0	0	174	22	185	0	98	0	0	0
RTOR Reduction (vph)	0	0	0	0	5	0	0	0	83	0	0	0
Lane Group Flow (vph)	630	141	0	0	191	0	185	0	15	0	0	0
Heavy Vehicles (%)	2%	2%	0%	0%	2%	0%	2%	0%	2%	0%	0%	0%
Turn Type	pm+pt						custom		custom			
Protected Phases	7	4			8							
Permitted Phases	4						2		2			
Actuated Green, G (s)	66.0	66.0			22.9		14.0		14.0			
Effective Green, g (s)	66.0	66.0			22.9		14.0		14.0			
Actuated g/C Ratio	0.73	0.73			0.25		0.16		0.16			
Clearance Time (s)	5.0	5.0			5.0		5.0		5.0			
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Lane Grp Cap (vph)	1074	1366			468		275		246			
v/s Ratio Prot	c0.25	0.08			0.10							
v/s Ratio Perm	c0.18						c0.10		0.01			
v/c Ratio	0.59	0.10			0.41		0.67		0.06			
Uniform Delay, d1	8.1	3.5			27.9		35.8		32.4			
Progression Factor	0.61	0.52			0.48		1.00		1.00			
Incremental Delay, d2	0.7	0.1			0.6		6.3		0.1			
Delay (s)	5.6	1.9			13.9		42.2		32.5			
Level of Service	A	A			B		D		C			
Approach Delay (s)		4.9			13.9			38.8			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	14.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	63.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)
40: 199th Street & East Waverley — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	200	10	5	160	10	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	217	11	5	174	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	820					
pX, platoon unblocked						
vC, conflicting volume			228		408	223
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			228		408	223
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	99
cM capacity (veh/h)			1352		601	822

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	228	179	16
Volume Left	0	5	11
Volume Right	11	0	5
cSH	1700	1352	660
Volume to Capacity	0.13	0.00	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.3	10.6
Lane LOS		A	B
Approach Delay (s)	0.0	0.3	10.6
Approach LOS			B

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	22.5%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Wellsville North No Action - PM Peak - Synchro Intersection LOS

1: 175th Street & Waverly Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	10	330	10	20	30	630	210	10	10	130	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.91		1.00	0.99		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1677		1805	1819		1770	3517		1805	3407	
Flt Permitted	0.72	1.00		0.41	1.00		0.57	1.00		0.61	1.00	
Satd. Flow (perm)	1346	1677		784	1819		1071	3517		1154	3407	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	53	11	347	11	21	32	663	221	11	11	137	42
RTOR Reduction (vph)	0	310	0	0	29	0	0	3	0	0	20	0
Lane Group Flow (vph)	53	48	0	11	24	0	663	229	0	11	159	0
Heavy Vehicles (%)	2%	0%	2%	0%	0%	0%	2%	2%	0%	0%	2%	3%
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	9.7	9.7		9.7	9.7		70.3	64.5		45.7	44.9	
Effective Green, g (s)	9.7	9.7		9.7	9.7		70.3	64.5		45.7	44.9	
Actuated g/C Ratio	0.11	0.11		0.11	0.11		0.78	0.72		0.51	0.50	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	145	181		84	196		995	2521		592	1700	
v/s Ratio Prot		0.03			0.01		c0.15	0.07		0.00	0.05	
v/s Ratio Perm	c0.04			0.01			c0.37			0.01		
v/c Ratio	0.37	0.27		0.13	0.12		0.67	0.09		0.02	0.09	
Uniform Delay, d1	37.3	36.9		36.3	36.3		3.8	3.9		11.0	11.9	
Progression Factor	1.00	1.00		1.00	1.00		0.93	0.58		1.00	1.00	
Incremental Delay, d2	1.6	0.8		0.7	0.3		1.5	0.1		0.0	0.1	
Delay (s)	38.9	37.7		37.0	36.6		5.0	2.3		11.0	12.0	
Level of Service	D	D		D	D		A	A		B	B	
Approach Delay (s)		37.8			36.7			4.3			11.9	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM Average Control Delay	15.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	72.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

2: US 56 & Gardner Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	130	440	60	300	890	440	50	890	220	320	930	120
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3551	1583	1770	3689	1583	1770	3725	1568	3400	3479	
Flt Permitted	0.17	1.00	1.00	0.35	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	317	3551	1583	661	3689	1583	1770	3725	1568	3400	3479	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	463	63	316	937	463	53	937	232	337	979	126
RTOR Reduction (vph)	0	0	47	0	0	249	0	0	162	0	11	0
Lane Group Flow (vph)	137	463	16	316	937	214	53	937	70	337	1094	0
Heavy Vehicles (%)	2%	7%	2%	2%	3%	2%	2%	2%	3%	3%	2%	2%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			
Actuated Green, G (s)	29.3	23.5	23.5	37.3	29.0	29.0	4.4	27.2	27.2	11.3	34.1	
Effective Green, g (s)	29.3	23.5	23.5	37.3	29.0	29.0	4.4	27.2	27.2	11.3	34.1	
Actuated g/C Ratio	0.33	0.26	0.26	0.41	0.32	0.32	0.05	0.30	0.30	0.13	0.38	
Clearance Time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	197	927	413	413	1189	510	87	1126	474	427	1318	
v/s Ratio Prot	0.04	0.13		c0.10	c0.25		0.03	c0.25		0.10	c0.31	
v/s Ratio Perm	0.18		0.01	0.22		0.13			0.04			
v/c Ratio	0.70	0.50	0.04	0.77	0.79	0.42	0.61	0.83	0.15	0.79	0.83	
Uniform Delay, d1	23.1	28.3	24.8	19.3	27.7	23.9	42.0	29.3	22.9	38.2	25.3	
Progression Factor	1.18	0.71	0.67	0.67	0.80	0.60	0.86	0.75	1.89	1.00	1.00	
Incremental Delay, d2	9.9	1.9	0.2	5.9	3.8	1.8	6.8	3.2	0.1	9.4	4.5	
Delay (s)	37.3	21.9	16.8	18.8	26.0	16.0	42.7	25.2	43.4	47.6	29.8	
Level of Service	D	C	B	B	C	B	D	C	D	D	C	
Approach Delay (s)		24.6			22.0			29.4			34.0	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	27.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	14.1
Intersection Capacity Utilization	79.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

8: US-56 & I-35 SB Ramps

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	2720	280	660	1250	0	0	0	0	170	0	1560
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		0.99		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3486		1752	3725					1770		2787
Flt Permitted		1.00		0.20	1.00					0.95		1.00
Satd. Flow (perm)		3486		363	3725					1770		2787
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2863	295	695	1316	0	0	0	0	179	0	1642
RTOR Reduction (vph)	0	7	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	3151	0	695	1316	0	0	0	0	179	0	1642
Heavy Vehicles (%)	0%	2%	3%	3%	2%	0%	0%	0%	0%	2%	0%	2%
Turn Type				pm+pt						custom		custom
Protected Phases		2		1	6					4		5
Permitted Phases				6						4		4
Actuated Green, G (s)		70.0		45.3	45.3					10.0		59.7
Effective Green, g (s)		70.0		45.3	45.3					10.0		59.7
Actuated g/C Ratio		0.58		0.38	0.38					0.08		0.50
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2034		426	1406					148		1503
v/s Ratio Prot		c0.90		c0.34	0.35					0.10		c0.45
v/s Ratio Perm				c0.28								0.14
v/c Ratio		1.55		1.63	0.94					1.21		1.09
Uniform Delay, d1		25.0		34.6	36.0					55.0		30.2
Progression Factor		0.73		0.96	0.91					1.00		1.00
Incremental Delay, d2		247.4		291.5	8.8					141.2		52.8
Delay (s)		265.7		324.9	41.5					196.2		82.9
Level of Service		F		F	D					F		F
Approach Delay (s)		265.7			139.4			0.0			94.1	
Approach LOS		F			F			A			F	

Intersection Summary			
HCM Average Control Delay	184.6	HCM Level of Service	F
HCM Volume to Capacity ratio	1.44		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	5.0
Intersection Capacity Utilization	141.8%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

9: US-56 & I-35 NB Ramps

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1530	0	0	1810	580	100	0	390	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95	0.95			
Frt		1.00			1.00	0.85	1.00	0.85	0.85			
Flt Protected		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (prot)		3725			3539	1538	1703	1421	1421			
Flt Permitted		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (perm)		3725			3539	1538	1703	1421	1421			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1611	0	0	1905	611	105	0	411	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	106	0	0	0	0	0	0
Lane Group Flow (vph)	0	1611	0	0	1905	505	105	206	205	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	5%	6%	0%	8%	0%	0%	0%
Turn Type						Perm	Perm		Perm			
Protected Phases		2			6			8				
Permitted Phases						6	8		8			
Actuated Green, G (s)		87.7			87.7	87.7	22.3	22.3	22.3			
Effective Green, g (s)		87.7			87.7	87.7	22.3	22.3	22.3			
Actuated g/C Ratio		0.73			0.73	0.73	0.19	0.19	0.19			
Clearance Time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0	3.0			
Lane Grp Cap (vph)		2722			2586	1124	316	264	264			
v/s Ratio Prot		0.43			c0.54			c0.15				
v/s Ratio Perm						0.33	0.06		0.14			
v/c Ratio		0.59			0.74	0.45	0.33	0.78	0.78			
Uniform Delay, d1		7.7			9.4	6.5	42.4	46.5	46.5			
Progression Factor		0.34			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2		0.1			1.1	0.3	0.6	13.8	13.3			
Delay (s)		2.7			10.5	6.8	43.0	60.4	59.8			
Level of Service		A			B	A	D	E	E			
Approach Delay (s)		2.7			9.6			56.6			0.0	
Approach LOS		A			A			E			A	

Intersection Summary			
HCM Average Control Delay	12.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	86.9%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
11: Waverly Road & US 56

2030 Wellsville No-Action
PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	150	20	310	110	40	60	130	0	30	190	630
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor		0.95	1.00	0.97	0.95		1.00	0.95		1.00	0.95	1.00
Frt		1.00	0.85	1.00	0.96		1.00	1.00		1.00	1.00	0.85
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)		3539	1615	3400	3372		1770	3282		1752	3438	1583
Flt Permitted		1.00	1.00	0.95	1.00		0.60	1.00		0.67	1.00	1.00
Satd. Flow (perm)		3539	1615	3400	3372		1117	3282		1227	3438	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	158	21	326	116	42	63	137	0	32	200	663
RTOR Reduction (vph)	0	0	19	0	29	0	0	0	0	0	0	362
Lane Group Flow (vph)	0	158	2	326	129	0	63	137	0	32	200	301
Heavy Vehicles (%)	0%	2%	0%	3%	2%	5%	2%	10%	0%	3%	5%	2%
Turn Type	Perm		Perm	Prot			pm+pt		Perm	pm+pt		Perm
Protected Phases		8		7	4		5	2		1	6	
Permitted Phases	8		8				2	2	2	6		6
Actuated Green, G (s)		9.4	9.4	13.8	28.2		48.6	42.7		45.0	40.9	40.9
Effective Green, g (s)		9.4	9.4	13.8	28.2		48.6	42.7		45.0	40.9	40.9
Actuated g/C Ratio		0.10	0.10	0.15	0.31		0.54	0.47		0.50	0.45	0.45
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)		370	169	521	1057		646	1557		637	1562	719
v/s Ratio Prot		c0.04		c0.10	0.04		c0.01	0.04		0.00	0.06	
v/s Ratio Perm			0.00				0.05			0.02		c0.19
v/c Ratio		0.43	0.01	0.63	0.12		0.10	0.09		0.05	0.13	0.42
Uniform Delay, d1		37.8	36.1	35.7	22.1		9.9	13.0		11.5	14.2	16.5
Progression Factor		0.99	0.96	0.92	0.82		1.27	1.24		0.36	0.34	3.09
Incremental Delay, d2		0.8	0.0	2.2	0.0		0.1	0.1		0.0	0.1	1.1
Delay (s)		38.3	34.8	35.1	18.2		12.6	16.2		4.1	5.0	52.3
Level of Service		D	C	D	B		B	B		A	A	D
Approach Delay (s)		37.9			29.6			15.0			40.0	
Approach LOS		D			C			B			D	

Intersection Summary			
HCM Average Control Delay	34.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	59.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
13: 183rd Street & US 56

2030 Wellsville No-Action
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	40	20	5	20	50	5	0	160	30	5	210	20
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	42	21	5	21	53	5	0	168	32	5	221	21
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	458	442	232	442	437	184	242			200		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	458	442	232	442	437	184	242			200		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	91	96	99	96	90	99	100			100		
cM capacity (veh/h)	467	511	813	508	511	863	1336			1384		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	68	79	200	247
Volume Left	42	21	0	5
Volume Right	5	5	32	21
cSH	496	525	1336	1384
Volume to Capacity	0.14	0.15	0.00	0.00
Queue Length 95th (ft)	12	13	0	0
Control Delay (s)	13.4	13.1	0.0	0.2
Lane LOS	B	B		A
Approach Delay (s)	13.4	13.1	0.0	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	3.4		
Intersection Capacity Utilization	30.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study
16: Four Corners Road & US 56

2030 Wellsville No-Action
PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	130	60	0	120	20	50	130	5	70	160	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	137	63	0	126	21	53	137	5	74	168	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	645	561	139	692	563	168	168			142		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	645	561	139	692	563	168	168			142		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	66	93	100	68	98	96			95		
cM capacity (veh/h)	268	399	909	231	398	881	1409			1447		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	205	147	195	242
Volume Left	5	0	53	74
Volume Right	63	21	5	0
cSH	475	431	1409	1447
Volume to Capacity	0.43	0.34	0.04	0.05
Queue Length 95th (ft)	54	37	3	4
Control Delay (s)	18.2	17.6	2.3	2.6
Lane LOS	C	C	A	A
Approach Delay (s)	18.2	17.6	2.3	2.6
Approach LOS	C	C		

Intersection Summary			
Average Delay	9.4		
Intersection Capacity Utilization	38.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study
17: 191st Street & US 56

2030 Wellsville No-Action
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	50	10	0	10	10	0	0	120	5	0	160	20
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	53	11	0	11	11	0	0	126	5	0	168	21
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	313	311	179	313	318	129	189			132		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	313	311	179	313	318	129	189			132		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	92	98	100	98	98	100	100			100		
cM capacity (veh/h)	631	607	869	635	601	926	1397			1466		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	63	21	132	189
Volume Left	53	11	0	0
Volume Right	0	0	5	21
cSH	627	618	1397	1466
Volume to Capacity	0.10	0.03	0.00	0.00
Queue Length 95th (ft)	8	3	0	0
Control Delay (s)	11.4	11.0	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	11.4	11.0	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	21.5%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Wellsville North No Action - PM Peak - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Wellsville No-Action

24: Sunflower Road & US 56

PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	50	10	360	20	5	10	120	280	5	180	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.98			1.00			0.91			1.00	
Flt Protected		1.00			0.96			1.00			1.00	
Satd. Flow (prot)		1826			1779			1650			1805	
Flt Permitted		1.00			0.69			0.99			0.99	
Satd. Flow (perm)		1826			1291			1640			1792	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	53	11	379	21	5	11	126	295	5	189	5
RTOR Reduction (vph)	0	7	0	0	1	0	0	70	0	0	1	0
Lane Group Flow (vph)	0	57	0	0	404	0	0	362	0	0	198	0
Heavy Vehicles (%)	0%	2%	0%	2%	0%	0%	0%	8%	3%	0%	5%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		34.6			34.6			45.4			45.4	
Effective Green, g (s)		34.6			34.6			45.4			45.4	
Actuated g/C Ratio		0.38			0.38			0.50			0.50	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		702			496			827			904	
v/s Ratio Prot		0.03										
v/s Ratio Perm					c0.31			c0.22			0.11	
v/c Ratio		0.08			0.82			0.44			0.22	
Uniform Delay, d1		17.6			24.8			14.2			12.4	
Progression Factor		1.00			1.15			0.83			0.54	
Incremental Delay, d2		0.1			7.3			1.6			0.6	
Delay (s)		17.7			35.8			13.4			7.2	
Level of Service		B			D			B			A	
Approach Delay (s)		17.7			35.8			13.4			7.2	
Approach LOS		B			D			B			A	

Intersection Summary			
HCM Average Control Delay	20.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville No-Action

25: US 56 & 4th Street

PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	330	130	90	460	150	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0			5.0	5.0	
Lane Util. Factor	1.00			1.00	1.00	
Frt	0.96			1.00	0.95	
Flt Protected	1.00			0.99	0.97	
Satd. Flow (prot)	1755			1833	1713	
Flt Permitted	1.00			0.85	0.97	
Satd. Flow (perm)	1755			1577	1713	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	347	137	95	484	158	84
RTOR Reduction (vph)	9	0	0	0	29	0
Lane Group Flow (vph)	475	0	0	579	213	0
Heavy Vehicles (%)	5%	2%	2%	3%	2%	3%
Turn Type			Perm			
Protected Phases	4			8	2	
Permitted Phases			8			
Actuated Green, G (s)	63.4			63.4	16.6	
Effective Green, g (s)	63.4			63.4	16.6	
Actuated g/C Ratio	0.70			0.70	0.18	
Clearance Time (s)	5.0			5.0	5.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	1236			1111	316	
v/s Ratio Prot	0.27				c0.12	
v/s Ratio Perm				c0.37		
v/c Ratio	0.38			0.52	0.68	
Uniform Delay, d1	5.4			6.2	34.2	
Progression Factor	1.00			0.54	1.00	
Incremental Delay, d2	0.9			1.6	5.6	
Delay (s)	6.3			4.9	39.8	
Level of Service	A			A	D	
Approach Delay (s)	6.3			4.9	39.8	
Approach LOS	A			A	D	

Intersection Summary			
HCM Average Control Delay	11.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	80.2%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville No-Action

28: I-35 SB Ramps & Sunflower Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	110	0	550	10	100	0	0	270	180
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)					5.0			5.0			5.0	
Lane Util. Factor					1.00			1.00			1.00	
Frt					0.89			1.00			0.95	
Flt Protected					0.99			1.00			1.00	
Satd. Flow (prot)					1640			1823			1745	
Flt Permitted					0.99			0.96			1.00	
Satd. Flow (perm)					1640			1754			1745	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	116	0	579	11	105	0	0	284	189
RTOR Reduction (vph)	0	0	0	0	370	0	0	0	0	0	14	0
Lane Group Flow (vph)	0	0	0	0	325	0	0	116	0	0	459	0
Heavy Vehicles (%)	0%	0%	0%	2%	0%	2%	20%	2%	0%	0%	3%	3%
Turn Type				custom			Perm					
Protected Phases				6	6			8			4	
Permitted Phases				6			8					
Actuated Green, G (s)					23.2			56.8			56.8	
Effective Green, g (s)					23.2			56.8			56.8	
Actuated g/C Ratio					0.26			0.63			0.63	
Clearance Time (s)					5.0			5.0			5.0	
Vehicle Extension (s)					3.0			3.0			3.0	
Lane Grp Cap (vph)					423			1107			1101	
v/s Ratio Prot					c0.20						c0.26	
v/s Ratio Perm								0.07				
v/c Ratio					0.77			0.10			0.42	
Uniform Delay, d1					30.9			6.6			8.3	
Progression Factor					1.00			0.41			1.00	
Incremental Delay, d2					8.1			0.2			1.2	
Delay (s)					39.0			2.9			9.5	
Level of Service					D			A			A	
Approach Delay (s)		0.0			39.0			2.9			9.5	
Approach LOS		A			D			A			A	

Intersection Summary			
HCM Average Control Delay	24.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	73.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville No-Action

29: I-35 NB Ramps & Sunflower Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	0	10	0	0	0	0	30	40	240	140	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.98						0.92			1.00	
Flt Protected		0.96						1.00			0.97	
Satd. Flow (prot)		1745						1637			1795	
Flt Permitted		0.96						1.00			0.76	
Satd. Flow (perm)		1745						1637			1414	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	84	0	11	0	0	0	0	32	42	253	147	0
RTOR Reduction (vph)	0	6	0	0	0	0	0	9	0	0	0	0
Lane Group Flow (vph)	0	89	0	0	0	0	0	65	0	0	400	0
Heavy Vehicles (%)	3%	0%	0%	0%	0%	0%	0%	10%	5%	3%	2%	0%
Turn Type	Perm									Perm		
Protected Phases		2						8			4	
Permitted Phases	2									4		
Actuated Green, G (s)		9.9						70.1			70.1	
Effective Green, g (s)		9.9						70.1			70.1	
Actuated g/C Ratio		0.11						0.78			0.78	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		192						1275			1101	
v/s Ratio Prot								0.04				
v/s Ratio Perm		0.05									c0.28	
v/c Ratio		0.46						0.05			0.36	
Uniform Delay, d1		37.6						2.3			3.1	
Progression Factor		1.00						1.00			0.71	
Incremental Delay, d2		1.8						0.1			0.8	
Delay (s)		39.3						2.4			3.0	
Level of Service		D						A			A	
Approach Delay (s)		39.3			0.0			2.4			3.0	
Approach LOS		D			A			A			A	

Intersection Summary			
HCM Average Control Delay	9.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	40.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

2030 Wellsville North No Action - PM Peak - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Wellsville No-Action
31: US 56 & Edgerton Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	200	30	60	390	50	40	50	20	90	100	10
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Hourly flow rate (vph)	11	217	33	65	424	54	42	53	22	98	105	11
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	478			250			900	864	234	885	853	451
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	478			250			900	864	234	885	853	451
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			95			75	81	97	53	62	98
cM capacity (veh/h)	1095			1310			172	275	810	209	279	612

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	261	543	116	214
Volume Left	11	65	42	98
Volume Right	33	54	22	11
cSH	1095	1310	251	248
Volume to Capacity	0.01	0.05	0.46	0.86
Queue Length 95th (ft)	1	4	57	177
Control Delay (s)	0.4	1.4	31.1	69.9
Lane LOS	A	A	D	F
Approach Delay (s)	0.4	1.4	31.1	69.9
Approach LOS			D	F

Intersection Summary			
Average Delay	17.1		
Intersection Capacity Utilization	65.2%	ICU Level of Service	C
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action
32: 207th & Sunflower Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	0	180	5	5	10	200	290	10	5	330	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	0	228	6	6	13	253	367	13	6	418	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1329	1320	421	1541	1316	373	424			380		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1329	1320	421	1541	1316	373	424			380		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	94	100	64	87	95	98	78			99		
cM capacity (veh/h)	104	122	628	50	123	677	1135			1190		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	234	25	633	430
Volume Left	6	6	253	6
Volume Right	228	13	13	6
cSH	553	129	1135	1190
Volume to Capacity	0.42	0.20	0.22	0.01
Queue Length 95th (ft)	52	17	21	0
Control Delay (s)	16.2	39.7	5.2	0.2
Lane LOS	C	E	A	A
Approach Delay (s)	16.2	39.7	5.2	0.2
Approach LOS	C	E		

Intersection Summary			
Average Delay	6.2		
Intersection Capacity Utilization	66.6%	ICU Level of Service	C
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action
33: 207th & COOP Rd — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	150	140	60	30	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	14	203	189	81	41	14
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	270				459	230
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	270				459	230
tC, single (s)	4.1				6.5	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.6	3.3
p0 queue free %	99				93	98
cM capacity (veh/h)	1305				545	814

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	216	270	54
Volume Left	14	0	41
Volume Right	0	81	14
cSH	1305	1700	594
Volume to Capacity	0.01	0.16	0.09
Queue Length 95th (ft)	1	0	7
Control Delay (s)	0.6	0.0	11.7
Lane LOS	A		B
Approach Delay (s)	0.6	0.0	11.7
Approach LOS			B

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	26.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action
34: 207th & Edgerton Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	10	0	10	10	130	5	10	5	140	5	10
Peak Hour Factor	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Hourly flow rate (vph)	15	15	0	15	15	197	8	15	8	212	8	15

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	30	227	30	235
Volume Left (vph)	15	15	8	212
Volume Right (vph)	0	197	8	15
Hadj (s)	0.10	-0.48	-0.10	0.17
Departure Headway (s)	4.9	4.1	4.7	4.7
Degree Utilization, x	0.04	0.26	0.04	0.31
Capacity (veh/h)	674	821	713	729
Control Delay (s)	8.1	8.6	7.9	9.7
Approach Delay (s)	8.1	8.6	7.9	9.7
Approach LOS	A	A	A	A

Intersection Summary			
Delay	9.0		
HCM Level of Service	A		
Intersection Capacity Utilization	31.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action
35: 207th & Evening Star Rd — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	20	5	5	20	5	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	40	10	10	40	10	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			50		105	45
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			50		105	45
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		99	99
cM capacity (veh/h)			1570		892	1031

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	50	50	20
Volume Left	0	10	10
Volume Right	10	0	10
cSH	1700	1570	956
Volume to Capacity	0.03	0.01	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	1.5	8.8
Lane LOS		A	A
Approach Delay (s)	0.0	1.5	8.8
Approach LOS			A

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	15.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action
36: 215th & Evening Star Rd — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	5	5	0	5	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	10	10	0	10	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	10				20	10
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	10				20	10
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	99
cM capacity (veh/h)	1623				1002	1077

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	10	10	20
Volume Left	0	0	10
Volume Right	0	0	10
cSH	1623	1700	1038
Volume to Capacity	0.00	0.01	0.02
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	0.0	8.5
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.5
Approach LOS			A

Intersection Summary			
Average Delay	4.3		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action
37: 199th Street & West Waverley — PM Peak Hour

Movement	EBL	EBT	WBU	WBT	WBR	SBL	SBR
Lane Configurations							
Volume (veh/h)	0	720	0	770	10	90	0
Sign Control		Free		Free		Stop	
Grade		0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	783	0	837	11	98	0
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type		TWLTL		TWLTL			
Median storage veh)		2		2			
Upstream signal (ft)				802			
pX, platoon unblocked			0.00				
vC, conflicting volume	848		0			1625	842
vC1, stage 1 conf vol						842	
vC2, stage 2 conf vol						783	
vCu, unblocked vol	848		0			1625	842
tC, single (s)	4.1		0.0			6.4	6.2
tC, 2 stage (s)						5.4	
tF (s)	2.2		0.0			3.5	3.3
p0 queue free %	100		0			69	100
cM capacity (veh/h)	798		0			320	367

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	0	783	848	0	98
Volume Left	0	0	0	0	98
Volume Right	0	0	11	0	0
cSH	1700	1700	1700	1700	320
Volume to Capacity	0.00	0.46	0.50	0.00	0.31
Queue Length 95th (ft)	0	0	0	0	32
Control Delay (s)	0.0	0.0	0.0	0.0	21.1
Lane LOS					C
Approach Delay (s)	0.0		0.0		21.1
Approach LOS					C

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	52.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action
38: 199th Street & IH-35 SB Ramp — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	600	210	140	190	0	0	0	0	10	0	600
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		2.5		2.5	2.5					2.5		2.5
Lane Util. Factor		1.00		1.00	1.00					1.00		1.00
Frt		0.97		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		1798		1770	1863					1805		1583
Flt Permitted		1.00		0.22	1.00					0.95		1.00
Satd. Flow (perm)		1798		410	1863					1805		1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	652	228	152	207	0	0	0	0	11	0	652
RTOR Reduction (vph)	0	8	0	0	0	0	0	0	0	0	0	598
Lane Group Flow (vph)	0	872	0	152	207	0	0	0	0	11	0	54
Heavy Vehicles (%)	0%	2%	2%	2%	2%	0%	0%	0%	0%	0%	0%	2%
Turn Type				pm+pt						Prot		custom
Protected Phases		4		3	8					6		
Permitted Phases				8								6
Actuated Green, G (s)		65.4		77.5	77.5					7.5		7.5
Effective Green, g (s)		65.4		77.5	77.5					7.5		7.5
Actuated g/C Ratio		0.73		0.86	0.86					0.08		0.08
Clearance Time (s)		2.5		2.5	2.5					2.5		2.5
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		1307		498	1604					150		132
v/s Ratio Prot		c0.48		c0.03	0.11					0.01		
v/s Ratio Perm				0.23								c0.03
v/c Ratio		0.67		0.31	0.13					0.07		0.41
Uniform Delay, d1		6.5		5.0	1.0					38.0		39.2
Progression Factor		0.93		4.43	0.78					1.00		1.00
Incremental Delay, d2		2.7		0.3	0.0					0.2		2.1
Delay (s)		8.7		22.5	0.8					38.3		41.2
Level of Service		A		C	A					D		D
Approach Delay (s)		8.7			10.0			0.0			41.2	
Approach LOS		A			A			A			D	

Intersection Summary			
HCM Average Control Delay	20.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	7.5
Intersection Capacity Utilization	65.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

BNSF NEPA Traffic Study
39: 199th Street & IH-35 NB Ramp

2030 Wellsville No-Action
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	500	120	0	0	280	20	50	0	50	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		2.5		2.5			
Lane Util. Factor	1.00	1.00			1.00		1.00		1.00			
Frt	1.00	1.00			0.99		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1770	1863			1848		1770		1583			
Flt Permitted	0.50	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	929	1863			1848		1770		1583			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	543	130	0	0	304	22	54	0	54	0	0	0
RTOR Reduction (vph)	0	0	0	0	2	0	0	0	50	0	0	0
Lane Group Flow (vph)	543	130	0	0	324	0	54	0	4	0	0	0
Heavy Vehicles (%)	2%	2%	0%	0%	2%	0%	2%	0%	2%	0%	0%	0%
Turn Type	pm+pt						Prot		custom			
Protected Phases	7	4			8		5					
Permitted Phases	4								5			
Actuated Green, G (s)	75.4	75.4			57.6		7.1		7.1			
Effective Green, g (s)	75.4	75.4			57.6		7.1		7.1			
Actuated g/C Ratio	0.84	0.84			0.64		0.08		0.08			
Clearance Time (s)	5.0	5.0			5.0		2.5		2.5			
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Lane Grp Cap (vph)	898	1561			1183		140		125			
v/s Ratio Prot	c0.09	0.07			0.18		c0.03					
v/s Ratio Perm	c0.42								0.00			
v/c Ratio	0.60	0.08			0.27		0.39		0.03			
Uniform Delay, d1	2.3	1.3			7.1		39.4		38.3			
Progression Factor	1.58	0.88			1.00		1.00		1.00			
Incremental Delay, d2	0.9	0.1			0.1		1.8		0.1			
Delay (s)	4.5	1.2			7.2		41.1		38.4			
Level of Service	A	A			A		D		D			
Approach Delay (s)		3.9			7.2			39.8			0.0	
Approach LOS		A			A			D			A	

Intersection Summary			
HCM Average Control Delay	8.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	7.5
Intersection Capacity Utilization	65.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
40: 199th Street & East Waverley

2030 Wellsville No-Action
PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	160	10	5	290	10	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	174	11	5	315	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	820					
pX, platoon unblocked						
vC, conflicting volume			185		505	179
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			185		505	179
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	99
cM capacity (veh/h)			1402		528	869

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	185	321	16
Volume Left	0	5	11
Volume Right	11	0	5
cSH	1700	1402	607
Volume to Capacity	0.11	0.00	0.03
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.2	11.1
Lane LOS		A	B
Approach Delay (s)	0.0	0.2	11.1
Approach LOS			B

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	29.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)

1: 175th Street & Waverly Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	10	330	10	20	30	630	210	10	10	130	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.91		1.00	0.99		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1677		1805	1819		1770	3517		1805	3407	
Flt Permitted	0.72	1.00		0.41	1.00		0.57	1.00		0.61	1.00	
Satd. Flow (perm)	1346	1677		784	1819		1071	3517		1154	3407	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	53	11	347	11	21	32	663	221	11	11	137	42
RTOR Reduction (vph)	0	310	0	0	29	0	0	3	0	0	20	0
Lane Group Flow (vph)	53	48	0	11	24	0	663	229	0	11	159	0
Heavy Vehicles (%)	2%	0%	2%	0%	0%	0%	2%	2%	0%	0%	2%	3%
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	9.7	9.7		9.7	9.7		70.3	64.5		45.7	44.9	
Effective Green, g (s)	9.7	9.7		9.7	9.7		70.3	64.5		45.7	44.9	
Actuated g/C Ratio	0.11	0.11		0.11	0.11		0.78	0.72		0.51	0.50	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	145	181		84	196		995	2521		592	1700	
v/s Ratio Prot		0.03			0.01		c0.15	0.07		0.00	0.05	
v/s Ratio Perm	c0.04			0.01			c0.37			0.01		
v/c Ratio	0.37	0.27		0.13	0.12		0.67	0.09		0.02	0.09	
Uniform Delay, d1	37.3	36.9		36.3	36.3		3.8	3.9		11.0	11.9	
Progression Factor	1.00	1.00		1.00	1.00		0.93	0.58		1.00	1.00	
Incremental Delay, d2	1.6	0.8		0.7	0.3		1.5	0.1		0.0	0.1	
Delay (s)	38.9	37.7		37.0	36.6		5.0	2.3		11.0	12.0	
Level of Service	D	D		D	D		A	A		B	B	
Approach Delay (s)		37.8			36.7			4.3			11.9	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM Average Control Delay	15.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	72.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)

2: US 56 & Gardner Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	130	440	60	300	890	440	50	890	220	320	930	120
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3551	1583	1770	3689	1583	1770	3725	1568	3400	3479	
Flt Permitted	0.17	1.00	1.00	0.35	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	317	3551	1583	661	3689	1583	1770	3725	1568	3400	3479	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	463	63	316	937	463	53	937	232	337	979	126
RTOR Reduction (vph)	0	0	47	0	0	249	0	0	162	0	11	0
Lane Group Flow (vph)	137	463	16	316	937	214	53	937	70	337	1094	0
Heavy Vehicles (%)	2%	7%	2%	2%	3%	2%	2%	2%	3%	3%	2%	2%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			
Actuated Green, G (s)	29.3	23.5	23.5	37.3	29.0	29.0	4.4	27.2	27.2	11.3	34.1	
Effective Green, g (s)	29.3	23.5	23.5	37.3	29.0	29.0	4.4	27.2	27.2	11.3	34.1	
Actuated g/C Ratio	0.33	0.26	0.26	0.41	0.32	0.32	0.05	0.30	0.30	0.13	0.38	
Clearance Time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	197	927	413	413	1189	510	87	1126	474	427	1318	
v/s Ratio Prot	0.04	0.13		c0.10	c0.25		0.03	c0.25		0.10	c0.31	
v/s Ratio Perm	0.18		0.01	0.22		0.13			0.04			
v/c Ratio	0.70	0.50	0.04	0.77	0.79	0.42	0.61	0.83	0.15	0.79	0.83	
Uniform Delay, d1	23.1	28.3	24.8	19.3	27.7	23.9	42.0	29.3	22.9	38.2	25.3	
Progression Factor	1.18	0.70	0.67	0.67	0.80	0.60	0.85	0.72	1.75	1.00	1.00	
Incremental Delay, d2	9.9	1.9	0.2	5.9	3.8	1.8	6.8	3.2	0.1	9.4	4.5	
Delay (s)	37.2	21.8	16.8	18.8	26.0	16.0	42.3	24.2	40.2	47.6	29.8	
Level of Service	D	C	B	B	C	B	D	C	D	D	C	
Approach Delay (s)		24.5			22.0			28.0			34.0	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	27.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	14.1
Intersection Capacity Utilization	79.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)

8: US-56 & I-35 SB Ramps — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	2720	280	660	1250	0	0	0	0	170	0	1560
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		0.99		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3486		1752	3725					1770		2787
Flt Permitted		1.00		0.18	1.00					0.95		1.00
Satd. Flow (perm)		3486		337	3725					1770		2787
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2863	295	695	1316	0	0	0	0	179	0	1642
RTOR Reduction (vph)	0	7	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	3151	0	695	1316	0	0	0	0	179	0	1642
Heavy Vehicles (%)	0%	2%	3%	3%	2%	0%	0%	0%	0%	2%	0%	2%
Turn Type				pm+pt						custom		custom
Protected Phases		2		1	6					4		5
Permitted Phases				6						4		4
Actuated Green, G (s)		71.0		45.9	45.9					10.0		59.1
Effective Green, g (s)		71.0		45.9	45.9					10.0		59.1
Actuated g/C Ratio		0.59		0.38	0.38					0.08		0.49
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2063		412	1425					148		1489
v/s Ratio Prot		c0.90		c0.34	0.35					0.10		c0.45
v/s Ratio Perm				c0.31								0.14
v/c Ratio		1.53		1.69	0.92					1.21		1.10
Uniform Delay, d1		24.5		34.9	35.4					55.0		30.4
Progression Factor		0.82		0.97	0.92					1.00		1.00
Incremental Delay, d2		237.7		316.4	7.6					141.2		56.8
Delay (s)		257.7		350.0	40.2					196.2		87.3
Level of Service		F		F	D					F		F
Approach Delay (s)		257.7			147.3			0.0			98.0	
Approach LOS		F			F			A			F	

Intersection Summary			
HCM Average Control Delay	184.3	HCM Level of Service	F
HCM Volume to Capacity ratio	1.45		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	5.0
Intersection Capacity Utilization	141.8%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)

9: US-56 & I-35 NB Ramps — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1530	0	0	1810	580	100	0	390	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95	0.95			
Frt		1.00			1.00	0.85	1.00	0.85	0.85			
Flt Protected		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (prot)		3725			3539	1538	1703	1421	1421			
Flt Permitted		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (perm)		3725			3539	1538	1703	1421	1421			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1611	0	0	1905	611	105	0	411	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	106	0	0	0	0	0	0
Lane Group Flow (vph)	0	1611	0	0	1905	505	105	206	205	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	5%	6%	0%	8%	0%	0%	0%
Turn Type						Perm	Perm		Perm			
Protected Phases		2			6			8				
Permitted Phases						6	8		8			
Actuated Green, G (s)		87.7			87.7	87.7	22.3	22.3	22.3			
Effective Green, g (s)		87.7			87.7	87.7	22.3	22.3	22.3			
Actuated g/C Ratio		0.73			0.73	0.73	0.19	0.19	0.19			
Clearance Time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0	3.0			
Lane Grp Cap (vph)		2722			2586	1124	316	264	264			
v/s Ratio Prot		0.43			c0.54			c0.15				
v/s Ratio Perm						0.33	0.06		0.14			
v/c Ratio		0.59			0.74	0.45	0.33	0.78	0.78			
Uniform Delay, d1		7.7			9.4	6.5	42.4	46.5	46.5			
Progression Factor		0.35			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2		0.1			1.1	0.3	0.6	13.8	13.3			
Delay (s)		2.8			10.5	6.8	43.0	60.4	59.8			
Level of Service		A			B	A	D	E	E			
Approach Delay (s)		2.8			9.6			56.6			0.0	
Approach LOS		A			A			E			A	

Intersection Summary			
HCM Average Control Delay	12.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	86.9%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
2030 Wellsville No-Action - (Improved)

11: Waverly Road & US 56

PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	150	20	310	110	40	60	130	0	30	190	630
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor		0.95	1.00	0.97	0.95		1.00	0.95		1.00	0.95	1.00
Frt		1.00	0.85	1.00	0.96		1.00	1.00		1.00	1.00	0.85
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)		3539	1615	3400	3372		1770	3282		1752	3438	1583
Flt Permitted		1.00	1.00	0.95	1.00		0.60	1.00		0.67	1.00	1.00
Satd. Flow (perm)		3539	1615	3400	3372		1117	3282		1227	3438	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	158	21	326	116	42	63	137	0	32	200	663
RTOR Reduction (vph)	0	0	19	0	29	0	0	0	0	0	0	362
Lane Group Flow (vph)	0	158	2	326	129	0	63	137	0	32	200	301
Heavy Vehicles (%)	0%	2%	0%	3%	2%	5%	2%	10%	0%	3%	5%	2%
Turn Type	Perm		Perm	Prot			pm+pt		Perm	pm+pt		Perm
Protected Phases		8		7	4		5	2		1	6	
Permitted Phases	8		8				2	2	2	6		6
Actuated Green, G (s)		9.4	9.4	13.8	28.2		48.6	42.7		45.0	40.9	40.9
Effective Green, g (s)		9.4	9.4	13.8	28.2		48.6	42.7		45.0	40.9	40.9
Actuated g/C Ratio		0.10	0.10	0.15	0.31		0.54	0.47		0.50	0.45	0.45
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)		370	169	521	1057		646	1557		637	1562	719
v/s Ratio Prot		c0.04		c0.10	0.04		c0.01	0.04		0.00	0.06	
v/s Ratio Perm			0.00				0.05			0.02		c0.19
v/c Ratio		0.43	0.01	0.63	0.12		0.10	0.09		0.05	0.13	0.42
Uniform Delay, d1		37.8	36.1	35.7	22.1		9.9	13.0		11.5	14.2	16.5
Progression Factor		1.00	0.97	0.92	0.82		1.18	1.18		0.36	0.34	3.09
Incremental Delay, d2		0.8	0.0	2.2	0.0		0.1	0.1		0.0	0.1	1.1
Delay (s)		38.4	35.0	35.1	18.2		11.8	15.5		4.1	5.0	52.3
Level of Service		D	C	D	B		B	B		A	A	D
Approach Delay (s)		38.0			29.6			14.3			40.0	
Approach LOS		D			C			B			D	

Intersection Summary				
HCM Average Control Delay	34.0	HCM Level of Service	C	
HCM Volume to Capacity ratio	0.43			
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0	
Intersection Capacity Utilization	59.0%	ICU Level of Service	B	
Analysis Period (min)	15			

c Critical Lane Group

BNSF NEPA Traffic Study
2030 Wellsville No-Action - (Improved)

13: 183rd Street & US 56

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	40	20	5	20	50	5	0	160	30	5	210	20
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	42	21	5	21	53	5	0	168	32	5	221	21
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	458	442	232	442	437	184	242			200		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	458	442	232	442	437	184	242			200		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	91	96	99	96	90	99	100			100		
cM capacity (veh/h)	467	511	813	508	511	863	1336			1384		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	68	79	200	247
Volume Left	42	21	0	5
Volume Right	5	5	32	21
cSH	496	525	1336	1384
Volume to Capacity	0.14	0.15	0.00	0.00
Queue Length 95th (ft)	12	13	0	0
Control Delay (s)	13.4	13.1	0.0	0.2
Lane LOS	B	B		A
Approach Delay (s)	13.4	13.1	0.0	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	3.4		
Intersection Capacity Utilization	30.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study
2030 Wellsville No-Action - (Improved)

16: Four Corners Road & US 56

PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	130	60	0	120	20	50	130	5	70	160	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	137	63	0	126	21	53	137	5	74	168	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	645	561	139	692	563	168	168			142		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	645	561	139	692	563	168	168			142		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	66	93	100	68	98	96			95		
cM capacity (veh/h)	268	399	909	231	398	881	1409			1447		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	205	147	195	242
Volume Left	5	0	53	74
Volume Right	63	21	5	0
cSH	475	431	1409	1447
Volume to Capacity	0.43	0.34	0.04	0.05
Queue Length 95th (ft)	54	37	3	4
Control Delay (s)	18.2	17.6	2.3	2.6
Lane LOS	C	C	A	A
Approach Delay (s)	18.2	17.6	2.3	2.6
Approach LOS	C	C		

Intersection Summary			
Average Delay	9.4		
Intersection Capacity Utilization	38.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study
2030 Wellsville No-Action - (Improved)

17: 191st Street & US 56

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	50	10	0	10	10	0	0	120	5	0	160	20
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	53	11	0	11	11	0	0	126	5	0	168	21
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	313	311	179	313	318	129	189			132		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	313	311	179	313	318	129	189			132		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	92	98	100	98	98	100	100			100		
cM capacity (veh/h)	631	607	869	635	601	926	1397			1466		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	63	21	132	189
Volume Left	53	11	0	0
Volume Right	0	0	5	21
cSH	627	618	1397	1466
Volume to Capacity	0.10	0.03	0.00	0.00
Queue Length 95th (ft)	8	3	0	0
Control Delay (s)	11.4	11.0	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	11.4	11.0	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	21.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study
24: Sunflower Road & US 56

2030 Wellsville No-Action - (Improved)
PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	50	10	360	20	5	10	120	280	5	180	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.98			1.00			0.91			1.00	
Flt Protected		1.00			0.96			1.00			1.00	
Satd. Flow (prot)		1826			1779			1650			1805	
Flt Permitted		1.00			0.69			0.99			0.99	
Satd. Flow (perm)		1826			1291			1640			1792	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	53	11	379	21	5	11	126	295	5	189	5
RTOR Reduction (vph)	0	7	0	0	1	0	0	71	0	0	1	0
Lane Group Flow (vph)	0	57	0	0	404	0	0	361	0	0	198	0
Heavy Vehicles (%)	0%	2%	0%	2%	0%	0%	0%	8%	3%	0%	5%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		34.3			34.3			45.7			45.7	
Effective Green, g (s)		34.3			34.3			45.7			45.7	
Actuated g/C Ratio		0.38			0.38			0.51			0.51	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		696			492			833			910	
v/s Ratio Prot		0.03										
v/s Ratio Perm					c0.31			c0.22			0.11	
v/c Ratio		0.08			0.82			0.43			0.22	
Uniform Delay, d1		17.8			25.1			14.0			12.3	
Progression Factor		1.00			1.05			0.67			0.58	
Incremental Delay, d2		0.1			7.8			1.5			0.5	
Delay (s)		17.8			34.1			11.0			7.6	
Level of Service		B			C			B			A	
Approach Delay (s)		17.8			34.1			11.0			7.6	
Approach LOS		B			C			B			A	

Intersection Summary			
HCM Average Control Delay	19.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
25: US 56 & 4th Street

2030 Wellsville No-Action - (Improved)
PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	330	130	90	460	150	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0	4.0	
Lane Util. Factor	1.00			1.00	1.00	
Frt	0.96			1.00	0.95	
Flt Protected	1.00			0.99	0.97	
Satd. Flow (prot)	1755			1833	1713	
Flt Permitted	1.00			0.86	0.97	
Satd. Flow (perm)	1755			1583	1713	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	347	137	95	484	158	84
RTOR Reduction (vph)	12	0	0	0	24	0
Lane Group Flow (vph)	472	0	0	579	218	0
Heavy Vehicles (%)	5%	2%	2%	3%	2%	3%
Turn Type			Perm			
Protected Phases	4			8	2	
Permitted Phases			8			
Actuated Green, G (s)	65.4			65.4	16.6	
Effective Green, g (s)	65.4			65.4	16.6	
Actuated g/C Ratio	0.73			0.73	0.18	
Clearance Time (s)	4.0			4.0	4.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	1275			1150	316	
v/s Ratio Prot	0.27				c0.13	
v/s Ratio Perm				c0.37		
v/c Ratio	0.37			0.50	0.69	
Uniform Delay, d1	4.6			5.3	34.3	
Progression Factor	1.00			0.67	1.00	
Incremental Delay, d2	0.8			1.4	6.4	
Delay (s)	5.4			4.9	40.7	
Level of Service	A			A	D	
Approach Delay (s)	5.4			4.9	40.7	
Approach LOS	A			A	D	

Intersection Summary			
HCM Average Control Delay	11.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	77.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
28: I-35 SB Ramps & Sunflower Road

2030 Wellsville No-Action - (Improved)
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	110	0	550	10	100	0	0	270	180
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)					5.0			5.0			5.0	
Lane Util. Factor					1.00			1.00			1.00	
Frt					0.89			1.00			0.95	
Flt Protected					0.99			1.00			1.00	
Satd. Flow (prot)					1640			1823			1745	
Flt Permitted					0.99			0.96			1.00	
Satd. Flow (perm)					1640			1753			1745	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	116	0	579	11	105	0	0	284	189
RTOR Reduction (vph)	0	0	0	0	282	0	0	0	0	0	18	0
Lane Group Flow (vph)	0	0	0	0	413	0	0	116	0	0	455	0
Heavy Vehicles (%)	0%	0%	0%	2%	0%	2%	20%	2%	0%	0%	3%	3%
Turn Type				custom			Perm					
Protected Phases				6	6			8			4	
Permitted Phases				6			8					
Actuated Green, G (s)					27.7			52.3			52.3	
Effective Green, g (s)					27.7			52.3			52.3	
Actuated g/C Ratio					0.31			0.58			0.58	
Clearance Time (s)					5.0			5.0			5.0	
Vehicle Extension (s)					3.0			3.0			3.0	
Lane Grp Cap (vph)					505			1019			1014	
v/s Ratio Prot					c0.25						c0.26	
v/s Ratio Perm								0.07				
v/c Ratio					0.82			0.11			0.45	
Uniform Delay, d1					28.8			8.5			10.7	
Progression Factor					1.00			0.57			1.00	
Incremental Delay, d2					9.9			0.2			1.4	
Delay (s)					38.7			5.0			12.1	
Level of Service					D			A			B	
Approach Delay (s)		0.0			38.7			5.0			12.1	
Approach LOS		A			D			A			B	

Intersection Summary			
HCM Average Control Delay	25.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	73.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
29: I-35 NB Ramps & Sunflower Road

2030 Wellsville No-Action - (Improved)
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	0	10	0	0	0	0	30	40	240	140	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.98						0.92			1.00	
Flt Protected		0.96						1.00			0.97	
Satd. Flow (prot)		1745						1637			1795	
Flt Permitted		0.96						1.00			0.76	
Satd. Flow (perm)		1745						1637			1414	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	84	0	11	0	0	0	0	32	42	253	147	0
RTOR Reduction (vph)	0	6	0	0	0	0	0	9	0	0	0	0
Lane Group Flow (vph)	0	89	0	0	0	0	0	65	0	0	400	0
Heavy Vehicles (%)	3%	0%	0%	0%	0%	0%	0%	10%	5%	3%	2%	0%
Turn Type	Perm									Perm		
Protected Phases		2						8			4	
Permitted Phases	2									4		
Actuated Green, G (s)		9.9						70.1			70.1	
Effective Green, g (s)		9.9						70.1			70.1	
Actuated g/C Ratio		0.11						0.78			0.78	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		192						1275			1101	
v/s Ratio Prot								0.04				
v/s Ratio Perm		0.05									c0.28	
v/c Ratio		0.46						0.05			0.36	
Uniform Delay, d1		37.6						2.3			3.1	
Progression Factor		1.00						1.00			0.67	
Incremental Delay, d2		1.8						0.1			0.8	
Delay (s)		39.3						2.4			2.9	
Level of Service		D						A			A	
Approach Delay (s)		39.3			0.0			2.4			2.9	
Approach LOS		D			A			A			A	

Intersection Summary			
HCM Average Control Delay	8.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	40.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

2030 Wellsville North No Action - (Improved) - PM Peak - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)

31: US 56 & Edgerton Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	200	30	60	390	50	40	50	20	90	100	10
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Hourly flow rate (vph)	11	217	33	65	424	54	42	53	22	98	105	11

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	261	543	116	214
Volume Left (vph)	11	65	42	98
Volume Right (vph)	33	54	22	11
Hadj (s)	0.04	0.01	-0.01	0.11
Departure Headway (s)	6.1	5.6	6.8	6.6
Degree Utilization, x	0.44	0.84	0.22	0.39
Capacity (veh/h)	550	543	468	500
Control Delay (s)	13.7	30.6	11.7	13.8
Approach Delay (s)	13.7	30.6	11.7	13.8
Approach LOS	B	D	B	B

Intersection Summary			
Delay	21.6		
HCM Level of Service	C		
Intersection Capacity Utilization	65.2%	ICU Level of Service	C
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)

32: 207th & Sunflower Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	0	180	5	5	10	200	290	10	5	330	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	0	228	6	6	13	253	367	13	6	418	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1329	1320	421	1541	1316	373	424			380		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1329	1320	421	1541	1316	373	424			380		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	94	100	64	87	95	98	78			99		
cM capacity (veh/h)	104	122	628	50	123	677	1135			1190		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	234	25	633	430
Volume Left	6	6	253	6
Volume Right	228	13	13	6
cSH	553	129	1135	1190
Volume to Capacity	0.42	0.20	0.22	0.01
Queue Length 95th (ft)	52	17	21	0
Control Delay (s)	16.2	39.7	5.2	0.2
Lane LOS	C	E	A	A
Approach Delay (s)	16.2	39.7	5.2	0.2
Approach LOS	C	E		

Intersection Summary			
Average Delay	6.2		
Intersection Capacity Utilization	66.6%	ICU Level of Service	C
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)

33: 207th & COOP Rd — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	150	140	60	30	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	14	203	189	81	41	14
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	270				459	230
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	270				459	230
tC, single (s)	4.1				6.5	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.6	3.3
p0 queue free %	99				93	98
cM capacity (veh/h)	1305				545	814

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	216	270	54
Volume Left	14	0	41
Volume Right	0	81	14
cSH	1305	1700	594
Volume to Capacity	0.01	0.16	0.09
Queue Length 95th (ft)	1	0	7
Control Delay (s)	0.6	0.0	11.7
Lane LOS	A		B
Approach Delay (s)	0.6	0.0	11.7
Approach LOS			B

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	26.1%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)

34: 207th & Edgerton Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	10	0	10	10	130	5	10	5	140	5	10
Peak Hour Factor	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Hourly flow rate (vph)	15	15	0	15	15	197	8	15	8	212	8	15

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	30	227	30	235
Volume Left (vph)	15	15	8	212
Volume Right (vph)	0	197	8	15
Hadj (s)	0.10	-0.48	-0.10	0.17
Departure Headway (s)	4.9	4.1	4.7	4.7
Degree Utilization, x	0.04	0.26	0.04	0.31
Capacity (veh/h)	674	821	713	729
Control Delay (s)	8.1	8.6	7.9	9.7
Approach Delay (s)	8.1	8.6	7.9	9.7
Approach LOS	A	A	A	A

Intersection Summary			
Delay	9.0		
HCM Level of Service	A		
Intersection Capacity Utilization	31.1%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Wellsville North No Action - (Improved) - PM Peak - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)
35: 207th & Evening Star Rd — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	20	5	5	20	5	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	40	10	10	40	10	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			50		105	45
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			50		105	45
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		99	99
cM capacity (veh/h)			1570		892	1031

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	50	50	20
Volume Left	0	10	10
Volume Right	10	0	10
cSH	1700	1570	956
Volume to Capacity	0.03	0.01	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	1.5	8.8
Lane LOS		A	A
Approach Delay (s)	0.0	1.5	8.8
Approach LOS			A

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	15.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)
36: 215th & Evening Star Rd — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	5	5	0	5	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	10	10	0	10	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	10				20	10
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	10				20	10
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	99
cM capacity (veh/h)	1623				1002	1077

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	10	10	20
Volume Left	0	0	10
Volume Right	0	0	10
cSH	1623	1700	1038
Volume to Capacity	0.00	0.01	0.02
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	0.0	8.5
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.5
Approach LOS			A

Intersection Summary			
Average Delay	4.3		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)
37: 199th Street & West Waverley — PM Peak Hour

Movement	EBL	EBT	WBU	WBT	WBR	SBL	SBR
Lane Configurations							
Volume (veh/h)	0	720	0	770	10	90	0
Sign Control		Free		Free		Stop	
Grade		0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	783	0	837	11	98	0
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type		TWLTL		TWLTL			
Median storage veh)		2		2			
Upstream signal (ft)				802			
pX, platoon unblocked			0.00				
vC, conflicting volume	848		0			1625	842
vC1, stage 1 conf vol						842	
vC2, stage 2 conf vol						783	
vCu, unblocked vol	848		0			1625	842
tC, single (s)	4.1		0.0			6.4	6.2
tC, 2 stage (s)						5.4	
tF (s)	2.2		0.0			3.5	3.3
p0 queue free %	100		0			69	100
cM capacity (veh/h)	798		0			320	367

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	0	783	848	0	98
Volume Left	0	0	0	0	98
Volume Right	0	0	11	0	0
cSH	1700	1700	1700	1700	320
Volume to Capacity	0.00	0.46	0.50	0.00	0.31
Queue Length 95th (ft)	0	0	0	0	32
Control Delay (s)	0.0	0.0	0.0	0.0	21.1
Lane LOS					C
Approach Delay (s)	0.0		0.0		21.1
Approach LOS					C

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	52.8%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)
38: 199th Street & IH-35 SB Ramp — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	600	210	140	190	0	0	0	0	10	0	600
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		2.5		2.5	2.5					2.5		2.5
Lane Util. Factor		1.00		1.00	1.00					1.00		1.00
Frt		0.97		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		1798		1770	1863					1805		1583
Flt Permitted		1.00		0.22	1.00					0.95		1.00
Satd. Flow (perm)		1798		410	1863					1805		1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	652	228	152	207	0	0	0	0	11	0	652
RTOR Reduction (vph)	0	8	0	0	0	0	0	0	0	0	0	598
Lane Group Flow (vph)	0	872	0	152	207	0	0	0	0	11	0	54
Heavy Vehicles (%)	0%	2%	2%	2%	2%	0%	0%	0%	0%	0%	0%	2%
Turn Type				pm+pt						Prot		custom
Protected Phases		4		3	8					6		
Permitted Phases				8								6
Actuated Green, G (s)		65.4		77.5	77.5					7.5		7.5
Effective Green, g (s)		65.4		77.5	77.5					7.5		7.5
Actuated g/C Ratio		0.73		0.86	0.86					0.08		0.08
Clearance Time (s)		2.5		2.5	2.5					2.5		2.5
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		1307		498	1604					150		132
v/s Ratio Prot		c0.48		c0.03	0.11					0.01		
v/s Ratio Perm				0.23								c0.03
v/c Ratio		0.67		0.31	0.13					0.07		0.41
Uniform Delay, d1		6.5		5.0	1.0					38.0		39.2
Progression Factor		0.95		6.48	0.11					1.00		1.00
Incremental Delay, d2		2.7		0.3	0.0					0.2		2.1
Delay (s)		8.9		32.8	0.1					38.3		41.2
Level of Service		A		C	A					D		D
Approach Delay (s)		8.9			14.0			0.0			41.2	
Approach LOS		A			B			A			D	

Intersection Summary			
HCM Average Control Delay	21.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	7.5
Intersection Capacity Utilization	65.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)
39: 199th Street & IH-35 NB Ramp — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	500	120	0	0	280	20	50	0	50	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0		5.0			
Lane Util. Factor	1.00	1.00			1.00		1.00		1.00			
Frt	1.00	1.00			0.99		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1770	1863			1848		1770		1583			
Flt Permitted	0.46	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	852	1863			1848		1770		1583			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	543	130	0	0	304	22	54	0	54	0	0	0
RTOR Reduction (vph)	0	0	0	0	2	0	0	0	50	0	0	0
Lane Group Flow (vph)	543	130	0	0	324	0	54	0	4	0	0	0
Heavy Vehicles (%)	2%	2%	0%	0%	2%	0%	2%	0%	2%	0%	0%	0%
Turn Type	pm+pt						custom		custom			
Protected Phases	7	4			8							
Permitted Phases	4						2		2			
Actuated Green, G (s)	72.9	72.9			34.1		7.1		7.1			
Effective Green, g (s)	72.9	72.9			34.1		7.1		7.1			
Actuated g/C Ratio	0.81	0.81			0.38		0.08		0.08			
Clearance Time (s)	5.0	5.0			5.0		5.0		5.0			
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Lane Grp Cap (vph)	1035	1509			700		140		125			
v/s Ratio Prot	c0.20	0.07			0.18							
v/s Ratio Perm	c0.23						c0.03		0.00			
v/c Ratio	0.52	0.09			0.46		0.39		0.03			
Uniform Delay, d1	6.9	1.7			21.0		39.4		38.3			
Progression Factor	0.41	0.31			0.33		1.00		1.00			
Incremental Delay, d2	0.4	0.1			0.4		1.8		0.1			
Delay (s)	3.2	0.6			7.3		41.1		38.4			
Level of Service	A	A			A		D		D			
Approach Delay (s)		2.7			7.3			39.8			0.0	
Approach LOS		A			A			D			A	

Intersection Summary			
HCM Average Control Delay	7.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	65.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville No-Action - (Improved)
40: 199th Street & East Waverley — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	160	10	5	290	10	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	174	11	5	315	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	820					
pX, platoon unblocked						
vC, conflicting volume			185		505	179
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			185		505	179
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	99
cM capacity (veh/h)			1402		528	869

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	185	321	16
Volume Left	0	5	11
Volume Right	11	0	5
cSH	1700	1402	607
Volume to Capacity	0.11	0.00	0.03
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.2	11.1
Lane LOS		A	B
Approach Delay (s)	0.0	0.2	11.1
Approach LOS			B

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	29.3%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Wellsville North Alternative - (Improved) - AM Peak Hour - Synchro Intersection LOS

1: 175th Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Volume (vph)	70	20	570	5	10	10	310	240	5	20	160	50
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.86		1.00	0.92		1.00	1.00		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1736	1678		1805	1850		1770	3497		1805	3331	
Flt Permitted	0.74	1.00		0.29	1.00		0.61	1.00		0.59	1.00	
Satd. Flow (perm)	1357	1678		551	1850		1143	3497		1125	3331	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	21	600	5	11	11	326	253	5	21	168	53
RTOR Reduction (vph)	0	508	0	0	9	0	0	1	0	0	18	0
Lane Group Flow (vph)	74	113	0	5	13	0	326	257	0	21	203	0
Heavy Vehicles (%)	4%	0%	2%	0%	0%	0%	2%	3%	0%	0%	4%	6%
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	13.8	13.8		13.8	13.8		66.2	59.2		54.5	52.5	
Effective Green, g (s)	13.8	13.8		13.8	13.8		66.2	59.2		54.5	52.5	
Actuated g/C Ratio	0.15	0.15		0.15	0.15		0.74	0.66		0.61	0.58	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	208	257		84	284		901	2300		696	1943	
v/s Ratio Prot		c0.07			0.01		c0.03	0.07		0.00	0.06	
v/s Ratio Perm	0.05			0.01			c0.23			0.02		
v/c Ratio	0.36	0.44		0.06	0.04		0.36	0.11		0.03	0.10	
Uniform Delay, d1	34.1	34.6		32.6	32.5		4.4	5.7		7.1	8.3	
Progression Factor	1.00	1.00		1.00	1.00		0.49	0.42		1.00	1.00	
Incremental Delay, d2	1.0	1.2		0.3	0.1		0.2	0.1		0.0	0.1	
Delay (s)	35.2	35.8		32.9	32.5		2.4	2.5		7.2	8.4	
Level of Service	D	D		C	C		A	A		A	A	
Approach Delay (s)		35.7			32.6			2.4			8.3	
Approach LOS		D			C			A			A	

Intersection Summary			
HCM Average Control Delay	18.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.37		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	70.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

2: US 56 & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↑	↱	↰	↑↑	↱	↰↰	↑↱	
Volume (vph)	150	790	60	180	440	220	80	1040	310	370	850	140
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1752	3619	1583	1687	3519	1538	1752	3689	1553	3367	3435	
Flt Permitted	0.41	1.00	1.00	0.16	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	764	3619	1583	284	3519	1538	1752	3689	1553	3367	3435	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	158	832	63	189	463	232	84	1095	326	389	895	147
RTOR Reduction (vph)	0	0	42	0	0	168	0	0	119	0	14	0
Lane Group Flow (vph)	158	832	21	189	463	64	84	1095	207	389	1028	0
Heavy Vehicles (%)	3%	5%	2%	7%	8%	5%	3%	3%	4%	4%	3%	2%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			
Actuated Green, G (s)	30.9	24.3	24.3	32.3	25.0	25.0	6.0	29.7	29.7	12.0	35.7	
Effective Green, g (s)	30.9	24.3	24.3	32.3	25.0	25.0	6.0	29.7	29.7	12.0	35.7	
Actuated g/C Ratio	0.34	0.27	0.27	0.36	0.28	0.28	0.07	0.33	0.33	0.13	0.40	
Clearance Time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	335	977	427	216	978	427	117	1217	512	449	1363	
v/s Ratio Prot	0.03	0.23		c0.07	0.13		0.05	c0.30		c0.12	0.30	
v/s Ratio Perm	0.13		0.01	c0.24		0.04			0.13			
v/c Ratio	0.47	0.85	0.05	0.88	0.47	0.15	0.72	0.90	0.40	0.87	0.75	
Uniform Delay, d1	21.4	31.1	24.3	22.7	27.0	24.5	41.2	28.7	23.3	38.2	23.4	
Progression Factor	0.53	0.61	0.30	1.35	1.07	2.63	0.72	0.58	0.23	1.00	1.00	
Incremental Delay, d2	1.0	8.7	0.2	28.9	1.6	0.7	12.7	6.2	0.3	15.9	2.4	
Delay (s)	12.2	27.9	7.5	59.5	30.4	65.1	42.5	22.9	5.6	54.2	25.8	
Level of Service	B	C	A	E	C	E	D	C	A	D	C	
Approach Delay (s)		24.3			45.7			20.2			33.5	
Approach LOS		C			D			C			C	

Intersection Summary			
HCM Average Control Delay	29.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	13.3
Intersection Capacity Utilization	85.0%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

8: US-56 & I-35 SB Ramps

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↱		↰	↑↑					↰		↱↱
Volume (vph)	0	2770	100	330	1450	0	0	0	0	210	0	1400
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		0.99		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3506		1719	3725					1736		2760
Flt Permitted		1.00		0.11	1.00					0.95		1.00
Satd. Flow (perm)		3506		207	3725					1736		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2916	105	347	1526	0	0	0	0	221	0	1474
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	8
Lane Group Flow (vph)	0	3019	0	347	1526	0	0	0	0	221	0	1466
Heavy Vehicles (%)	0%	2%	14%	5%	2%	0%	0%	0%	0%	4%	0%	3%
Turn Type				pm+pt						custom		custom
Protected Phases		2		1	6					4		5
Permitted Phases				6						4		4
Actuated Green, G (s)		77.0		50.9	50.9					12.0		54.1
Effective Green, g (s)		77.0		50.9	50.9					12.0		54.1
Actuated g/C Ratio		0.64		0.42	0.42					0.10		0.45
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2250		289	1580					174		1359
v/s Ratio Prot		c0.86		c0.16	0.41					0.13		c0.38
v/s Ratio Perm				0.35								0.15
v/c Ratio		1.34		1.20	0.97					1.27		1.08
Uniform Delay, d1		21.5		35.5	33.7					54.0		32.9
Progression Factor		0.71		0.90	0.87					1.00		1.00
Incremental Delay, d2		154.7		110.5	11.5					158.8		48.7
Delay (s)		169.9		142.3	40.8					212.8		81.7
Level of Service		F		F	D					F		F
Approach Delay (s)		169.9			59.6			0.0			98.8	
Approach LOS		F			E			A			F	

Intersection Summary			
HCM Average Control Delay	120.2	HCM Level of Service	F
HCM Volume to Capacity ratio	1.26		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	121.3%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

9: US-56 & I-35 NB Ramps

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑			↑↑	↱	↰	↱	↱			
Volume (vph)	0	1300	0	0	1610	550	170	0	730	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95	0.95			
Frt		1.00			1.00	0.85	1.00	0.85	0.85			
Flt Protected		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (prot)		3725			3539	1583	1671	1490	1490			
Flt Permitted		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (perm)		3725			3539	1583	1671	1490	1490			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1368	0	0	1695	579	179	0	768	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	121	0	0	0	0	0	0
Lane Group Flow (vph)	0	1368	0	0	1695	458	179	384	384	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	2%	8%	0%	3%	0%	0%	0%
Turn Type						Perm	Perm		Perm			
Protected Phases		2			6			8				
Permitted Phases						6	8		8			
Actuated Green, G (s)		74.0			74.0	74.0	36.0	36.0	36.0			
Effective Green, g (s)		74.0			74.0	74.0	36.0	36.0	36.0			
Actuated g/C Ratio		0.62			0.62	0.62	0.30	0.30	0.30			
Clearance Time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0	3.0			
Lane Grp Cap (vph)		2297			2182	976	501	447	447			
v/s Ratio Prot		0.37			c0.48			c0.26				
v/s Ratio Perm						0.29	0.11		0.26			
v/c Ratio		0.60			0.78	0.47	0.36	0.86	0.86			
Uniform Delay, d1		13.9			16.9	12.4	32.9	39.6	39.6			
Progression Factor		0.50			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2		0.1			1.8	0.4	0.4	15.1	15.1			
Delay (s)		7.0			18.7	12.8	33.4	54.7	54.7			
Level of Service		A			B	B	C	D	D			
Approach Delay (s)		7.0			17.2			50.7			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	21.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	106.7%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

2030 Wellsville North Alternative - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)

11: Waverly Road & US 56

AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	110	10	560	110	60	90	210	0	10	120	360
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor		0.95	1.00	0.97	0.95		1.00	0.95		1.00	0.95	1.00
Frt		1.00	0.85	1.00	0.95		1.00	1.00		1.00	1.00	0.85
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)		3539	1615	3400	3296		1752	3343		1805	3112	1568
Flt Permitted		1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)		3539	1615	3400	3296		1752	3343		1805	3112	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	116	11	589	116	63	95	221	0	11	126	379
RTOR Reduction (vph)	0	0	10	0	39	0	0	0	0	0	0	244
Lane Group Flow (vph)	0	116	1	589	140	0	95	221	0	11	126	135
Heavy Vehicles (%)	0%	2%	0%	3%	2%	7%	3%	8%	0%	0%	16%	3%
Turn Type	Prot		Perm	Prot			Prot		Perm	Prot		Perm
Protected Phases	3	8		7	4		5	2		1	6	
Permitted Phases			8					2	2			6
Actuated Green, G (s)		8.3	8.3	20.7	34.0		8.9	39.5		1.5	32.1	32.1
Effective Green, g (s)		8.3	8.3	20.7	34.0		8.9	39.5		1.5	32.1	32.1
Actuated g/C Ratio		0.09	0.09	0.23	0.38		0.10	0.44		0.02	0.36	0.36
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)		326	149	782	1245		173	1467		30	1110	559
v/s Ratio Prot		c0.03		c0.17	0.04		c0.05	0.07		0.01	0.04	
v/s Ratio Perm			0.00									c0.09
v/c Ratio		0.36	0.01	0.75	0.11		0.55	0.15		0.37	0.11	0.24
Uniform Delay, d1		38.3	37.1	32.3	18.2		38.6	15.2		43.8	19.4	20.4
Progression Factor		1.01	1.02	0.94	0.84		1.16	0.69		1.27	0.61	0.94
Incremental Delay, d2		0.7	0.0	3.7	0.0		3.3	0.2		6.4	0.2	0.9
Delay (s)		39.5	38.0	34.1	15.2		48.2	10.6		61.9	12.0	20.0
Level of Service		D	D	C	B		D	B		E	B	C
Approach Delay (s)		39.4			29.7			21.9			18.9	
Approach LOS		D			C			C			B	

Intersection Summary			
HCM Average Control Delay	25.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	43.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)

13: 183rd Street & US 56

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	20	20	5	30	20	5	0	280	30	5	150	30
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	21	5	32	21	5	0	295	32	5	158	32
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	511	511	174	511	511	311	189			326		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	511	511	174	511	511	311	189			326		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	95	95	99	93	95	99	100			100		
cM capacity (veh/h)	456	467	875	456	467	734	1397			1245		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	47	58	326	195
Volume Left	21	32	0	5
Volume Right	5	5	32	32
cSH	487	477	1397	1245
Volume to Capacity	0.10	0.12	0.00	0.00
Queue Length 95th (ft)	8	10	0	0
Control Delay (s)	13.2	13.6	0.0	0.3
Lane LOS	B	B		A
Approach Delay (s)	13.2	13.6	0.0	0.3
Approach LOS	B	B		

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	27.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)

16: Four Corners Road & US 56

AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	110	70	0	140	50	30	240	0	60	120	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	116	74	0	147	53	32	253	0	63	126	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	695	568	253	700	568	126	126			253		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	695	568	253	700	568	126	126			253		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	71	91	100	63	94	98			95		
cM capacity (veh/h)	231	402	788	239	402	924	1454			1313		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	195	200	284	189
Volume Left	5	0	32	63
Volume Right	74	53	0	0
cSH	482	473	1454	1313
Volume to Capacity	0.40	0.42	0.02	0.05
Queue Length 95th (ft)	48	52	2	4
Control Delay (s)	17.4	18.1	1.0	2.9
Lane LOS	C	C	A	A
Approach Delay (s)	17.4	18.1	1.0	2.9
Approach LOS	C	C		

Intersection Summary			
Average Delay	9.0		
Intersection Capacity Utilization	42.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)

17: 191st Street & US 56

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	20	10	5	5	10	5	0	250	10	0	110	60
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	11	5	5	11	5	0	263	11	0	116	63
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	426	421	147	426	447	268	179			274		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	426	421	147	426	447	268	179			274		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	96	98	99	99	98	99	100			100		
cM capacity (veh/h)	530	527	905	531	509	775	1409			1301		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	37	21	274	179
Volume Left	21	5	0	0
Volume Right	5	5	11	63
cSH	562	563	1409	1301
Volume to Capacity	0.07	0.04	0.00	0.00
Queue Length 95th (ft)	5	3	0	0
Control Delay (s)	11.9	11.6	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	11.9	11.6	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.3		
Intersection Capacity Utilization	24.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study
24: Sunflower Road & US 56

2030 Wellsville Alternative Action - (Improved)
AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		✣			✣			✣			✣	
Volume (vph)	5	20	5	280	30	5	5	250	370	5	110	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.98			1.00			0.92			1.00	
Flt Protected		0.99			0.96			1.00			1.00	
Satd. Flow (prot)		1844			1708			1677			1686	
Flt Permitted		0.95			0.73			1.00			0.98	
Satd. Flow (perm)		1763			1297			1676			1656	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	5	21	5	295	32	5	5	263	389	5	116	0
RTOR Reduction (vph)	0	3	0	0	1	0	0	50	0	0	0	0
Lane Group Flow (vph)	0	28	0	0	331	0	0	607	0	0	121	0
Heavy Vehicles (%)	0%	0%	0%	7%	1%	0%	0%	6%	3%	0%	13%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		27.2			27.2			52.8			52.8	
Effective Green, g (s)		27.2			27.2			52.8			52.8	
Actuated g/C Ratio		0.30			0.30			0.59			0.59	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		533			392			983			972	
v/s Ratio Prot												
v/s Ratio Perm		0.02			c0.26			c0.36			0.07	
v/c Ratio		0.05			0.85			0.62			0.12	
Uniform Delay, d1		22.3			29.4			12.1			8.3	
Progression Factor		1.00			0.89			1.31			1.53	
Incremental Delay, d2		0.0			12.5			2.5			0.3	
Delay (s)		22.3			38.6			18.3			13.0	
Level of Service		C			D			B			B	
Approach Delay (s)		22.3			38.6			18.3			13.0	
Approach LOS		C			D			B			B	

Intersection Summary			
HCM Average Control Delay	23.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	70.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
25: US 56 & 4th Street

2030 Wellsville Alternative Action - (Improved)
AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↱			↰	Y	
Volume (vph)	540	130	80	310	110	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0			5.0	5.0	
Lane Util. Factor	1.00			1.00	1.00	
Frt	0.97			1.00	0.94	
Flt Protected	1.00			0.99	0.97	
Satd. Flow (prot)	1782			1781	1672	
Flt Permitted	1.00			0.78	0.97	
Satd. Flow (perm)	1782			1399	1672	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	568	137	84	326	116	84
RTOR Reduction (vph)	7	0	0	0	32	0
Lane Group Flow (vph)	698	0	0	410	168	0
Heavy Vehicles (%)	4%	3%	4%	6%	5%	3%
Turn Type			Perm			
Protected Phases	4			8	2	
Permitted Phases			8			
Actuated Green, G (s)	65.9			65.9	14.1	
Effective Green, g (s)	65.9			65.9	14.1	
Actuated g/C Ratio	0.73			0.73	0.16	
Clearance Time (s)	5.0			5.0	5.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	1305			1024	262	
v/s Ratio Prot	c0.39				c0.10	
v/s Ratio Perm				0.29		
v/c Ratio	0.53			0.40	0.64	
Uniform Delay, d1	5.3			4.6	35.6	
Progression Factor	1.00			2.38	1.00	
Incremental Delay, d2	1.6			1.0	5.3	
Delay (s)	6.9			11.9	40.9	
Level of Service	A			B	D	
Approach Delay (s)	6.9			11.9	40.9	
Approach LOS	A			B	D	

Intersection Summary			
HCM Average Control Delay	13.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	80.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
28: I-35 SB Ramps & Sunflower Road

2030 Wellsville Alternative Action - (Improved)
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					✣			↰			↱	
Volume (vph)	0	0	0	20	0	320	5	190	0	0	800	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)					5.0			5.0			5.0	
Lane Util. Factor					1.00			1.00			1.00	
Frt					0.87			1.00			0.99	
Flt Protected					1.00			1.00			1.00	
Satd. Flow (prot)					1247			1745			1566	
Flt Permitted					1.00			0.98			1.00	
Satd. Flow (perm)					1247			1718			1566	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	21	0	337	5	200	0	0	842	95
RTOR Reduction (vph)	0	0	0	0	299	0	0	0	0	0	3	0
Lane Group Flow (vph)	0	0	0	0	59	0	0	205	0	0	934	0
Heavy Vehicles (%)	0%	0%	0%	10%	0%	34%	0%	9%	0%	0%	21%	8%
Turn Type				custom			Perm					
Protected Phases				6	6			8			4	
Permitted Phases				6			8					
Actuated Green, G (s)					10.2			69.8			69.8	
Effective Green, g (s)					10.2			69.8			69.8	
Actuated g/C Ratio					0.11			0.78			0.78	
Clearance Time (s)					5.0			5.0			5.0	
Vehicle Extension (s)					3.0			3.0			3.0	
Lane Grp Cap (vph)					141			1332			1215	
v/s Ratio Prot					c0.05						c0.60	
v/s Ratio Perm								0.12				
v/c Ratio					0.42			0.15			0.77	
Uniform Delay, d1					37.1			2.6			5.6	
Progression Factor					1.00			3.64			1.00	
Incremental Delay, d2					2.0			0.2			4.7	
Delay (s)					39.2			9.6			10.3	
Level of Service					D			A			B	
Approach Delay (s)		0.0			39.2			9.6			10.3	
Approach LOS		A			D			A			B	

Intersection Summary			
HCM Average Control Delay	17.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	76.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
29: I-35 NB Ramps & Sunflower Road

2030 Wellsville Alternative Action - (Improved)
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✣						↱			↰	
Volume (vph)	160	0	5	0	0	0	0	40	110	790	40	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		1.00						0.90			1.00	
Flt Protected		0.95						1.00			0.95	
Satd. Flow (prot)		1675						1652			1495	
Flt Permitted		0.95						1.00			0.63	
Satd. Flow (perm)		1675						1652			981	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	168	0	5	0	0	0	0	42	116	832	42	0
RTOR Reduction (vph)	0	1	0	0	0	0	0	30	0	0	0	0
Lane Group Flow (vph)	0	172	0	0	0	0	0	128	0	0	874	0
Heavy Vehicles (%)	8%	0%	0%	0%	0%	0%	0%	8%	2%	22%	8%	0%
Turn Type	Perm									Perm		
Protected Phases		2						8			4	
Permitted Phases	2									4		
Actuated Green, G (s)		13.5						66.5			66.5	
Effective Green, g (s)		13.5						66.5			66.5	
Actuated g/C Ratio		0.15						0.74			0.74	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		251						1221			725	
v/s Ratio Prot								0.08				
v/s Ratio Perm		0.10									c0.89	
v/c Ratio		0.69						0.10			1.21	
Uniform Delay, d1		36.2						3.3			11.7	
Progression Factor		1.00						1.00			0.93	
Incremental Delay, d2		7.6						0.2			100.9	
Delay (s)		43.8						3.5			111.9	
Level of Service		D						A			F	
Approach Delay (s)		43.8			0.0			3.5			111.9	
Approach LOS		D			A			A			F	

Intersection Summary			
HCM Average Control Delay	87.9	HCM Level of Service	F
HCM Volume to Capacity ratio	1.12		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	76.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

2030 Wellsville North Alternative - (Improved) - AM Peak Hour - Synchro Intersection LOS

31: US 56 & Edgerton Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	420	40	100	170	80	40	100	140	40	50	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Hourly flow rate (vph)	5	457	43	109	185	87	42	105	152	43	53	0

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	505	380	300	96
Volume Left (vph)	5	109	42	43
Volume Right (vph)	43	87	152	0
Hadj (s)	0.01	0.02	-0.04	0.15
Departure Headway (s)	6.2	6.5	6.9	7.9
Degree Utilization, x	0.87	0.69	0.58	0.21
Capacity (veh/h)	566	527	487	389
Control Delay (s)	38.0	22.4	18.9	13.0
Approach Delay (s)	38.0	22.4	18.9	13.0
Approach LOS	E	C	C	B

Intersection Summary			
Delay	27.0		
HCM Level of Service	D		
Intersection Capacity Utilization	70.8%	ICU Level of Service	C
Analysis Period (min)	15		

32: 207th & Sunflower Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	0	460	5	0	10	310	260	0	5	290	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	0	582	6	0	13	392	329	0	6	367	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1509	1497	370	2079	1500	329	373			329		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1509	1497	370	2079	1500	329	373			329		
tC, single (s)	7.1	6.5	6.6	7.1	6.5	6.2	4.5			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.6	3.5	4.0	3.3	2.5			2.2		
p0 queue free %	91	100	4	0	100	98	61			99		
cM capacity (veh/h)	68	76	604	1	75	717	1016			1242		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	589	19	722	380
Volume Left	6	6	392	6
Volume Right	582	13	0	6
cSH	557	3	1016	1242
Volume to Capacity	1.06	6.32	0.39	0.01
Queue Length 95th (ft)	424	Err	46	0
Control Delay (s)	80.9	Err	8.2	0.2
Lane LOS	F	F	A	A
Approach Delay (s)	80.9	Err	8.2	0.2
Approach LOS	F	F		

Intersection Summary			
Average Delay	142.5		
Intersection Capacity Utilization	85.6%	ICU Level of Service	E
Analysis Period (min)	15		

33: 207th & COOP Rd

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	20	390	290	10	60	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	27	527	392	14	81	14
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	405				980	399
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	405				980	399
tC, single (s)	4.1				6.4	6.5
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.6
p0 queue free %	98				70	98
cM capacity (veh/h)	1164				271	594

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	554	405	95
Volume Left	27	0	81
Volume Right	0	14	14
cSH	1164	1700	294
Volume to Capacity	0.02	0.24	0.32
Queue Length 95th (ft)	2	0	34
Control Delay (s)	0.7	0.0	23.0
Lane LOS	A		C
Approach Delay (s)	0.7	0.0	23.0
Approach LOS			C

Intersection Summary			
Average Delay	2.4		
Intersection Capacity Utilization	47.4%	ICU Level of Service	A
Analysis Period (min)	15		

34: 207th & Edgerton Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	80	250	0	0	190	120	0	10	0	160	5	70
Peak Hour Factor	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Hourly flow rate (vph)	121	379	0	0	288	182	0	15	0	242	8	106

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	500	470	15	356
Volume Left (vph)	121	0	0	242
Volume Right (vph)	0	182	0	106
Hadj (s)	0.96	0.44	0.34	0.05
Departure Headway (s)	7.3	6.8	8.9	7.0
Degree Utilization, x	1.02	0.89	0.04	0.69
Capacity (veh/h)	482	521	356	501
Control Delay (s)	72.7	43.1	12.2	24.2
Approach Delay (s)	72.7	43.1	12.2	24.2
Approach LOS	F	E	B	C

Intersection Summary			
Delay	48.8		
HCM Level of Service	E		
Intersection Capacity Utilization	65.0%	ICU Level of Service	C
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)

35: 207th & Evening Star Rd — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	10	0	250	10	0	310
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	20	0	500	20	0	620
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			20		1040	20
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			20		1040	20
tC, single (s)			4.6		6.4	6.8
tC, 2 stage (s)						
tF (s)			2.6		3.5	3.8
p0 queue free %			63		100	33
cM capacity (veh/h)			1348		162	919

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	20	520	620
Volume Left	0	500	0
Volume Right	0	0	620
cSH	1700	1348	919
Volume to Capacity	0.01	0.37	0.67
Queue Length 95th (ft)	0	44	136
Control Delay (s)	0.0	9.0	16.6
Lane LOS		A	C
Approach Delay (s)	0.0	9.0	16.6
Approach LOS			C

Intersection Summary			
Average Delay	12.9		
Intersection Capacity Utilization	46.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)

36: 215th & Evening Star Rd — AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	10	10	300	250	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	20	20	600	500	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	620				340	320
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	620				340	320
tC, single (s)	4.1				6.9	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.9	3.3
p0 queue free %	100				13	99
cM capacity (veh/h)	970				574	725

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	20	620	510
Volume Left	0	0	500
Volume Right	0	600	10
cSH	970	1700	576
Volume to Capacity	0.00	0.36	0.88
Queue Length 95th (ft)	0	0	257
Control Delay (s)	0.0	0.0	41.6
Lane LOS			E
Approach Delay (s)	0.0	0.0	41.6
Approach LOS			E

Intersection Summary			
Average Delay	18.4		
Intersection Capacity Utilization	39.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)

37: 199th Street & West Waverley — AM Peak Hour

Movement	EBL	EBT	WBU	WBT	WBR	SBL	SBR
Lane Configurations							
Volume (veh/h)	10	740	0	680	60	30	10
Sign Control		Free		Free		Stop	
Grade		0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	804	0	739	65	33	11
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type		TWLTL		TWLTL			
Median storage veh)		2		2			
Upstream signal (ft)				802			
pX, platoon unblocked			0.00				
vC, conflicting volume	804		0			1598	772
vC1, stage 1 conf vol						772	
vC2, stage 2 conf vol						826	
vCu, unblocked vol	804		0			1598	772
tC, single (s)	4.1		0.0			6.4	6.2
tC, 2 stage (s)						5.4	
tF (s)	2.2		0.0			3.5	3.3
p0 queue free %	99		0			90	97
cM capacity (veh/h)	829		0			322	403

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	11	804	804	0	43
Volume Left	11	0	0	0	33
Volume Right	0	0	65	0	11
cSH	829	1700	1700	1700	339
Volume to Capacity	0.01	0.47	0.47	0.00	0.13
Queue Length 95th (ft)	1	0	0	0	11
Control Delay (s)	9.4	0.0	0.0	0.0	17.2
Lane LOS	A				C
Approach Delay (s)	0.1		0.0		17.2
Approach LOS					C

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	49.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)

38: 199th Street & IH-35 SB Ramp — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	710	60	60	280	0	0	0	0	10	0	460
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		1.00		1.00	1.00					1.00		1.00
Frt		0.99		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		1843		1719	1845					1805		1583
Flt Permitted		1.00		0.25	1.00					0.95		1.00
Satd. Flow (perm)		1843		457	1845					1805		1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	772	65	65	304	0	0	0	0	11	0	500
RTOR Reduction (vph)	0	3	0	0	0	0	0	0	0	0	0	472
Lane Group Flow (vph)	0	834	0	65	304	0	0	0	0	11	0	28
Heavy Vehicles (%)	0%	2%	2%	5%	3%	0%	0%	0%	0%	0%	0%	2%
Turn Type				pm+pt						Prot		custom
Protected Phases		4		3	8					6		
Permitted Phases				8								6
Actuated Green, G (s)		66.8		75.0	75.0					5.0		5.0
Effective Green, g (s)		66.8		75.0	75.0					5.0		5.0
Actuated g/C Ratio		0.74		0.83	0.83					0.06		0.06
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		1368		426	1538					100		88
v/s Ratio Prot		c0.45		0.01	c0.16					0.01		
v/s Ratio Perm				0.12								c0.02
v/c Ratio		0.61		0.15	0.20					0.11		0.32
Uniform Delay, d1		5.5		3.8	1.5					40.4		40.9
Progression Factor		1.20		1.18	1.35					1.00		1.00
Incremental Delay, d2		2.0		0.2	0.1					0.5		2.1
Delay (s)		8.5		4.7	2.1					40.9		42.9
Level of Service		A		A	A					D		D
Approach Delay (s)		8.5			2.5			0.0			42.9	
Approach LOS		A			A			A			D	

Intersection Summary			
HCM Average Control Delay	17.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	64.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

2030 Wellsville North Alternative - (Improved) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)

39: 199th Street & IH-35 NB Ramp — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	580	130	0	0	170	20	170	0	100	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0		5.0			
Lane Util. Factor	1.00	1.00			1.00		1.00		1.00			
Frt	1.00	1.00			0.99		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1770	1845			1824		1770		1553			
Flt Permitted	0.54	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	998	1845			1824		1770		1553			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	630	141	0	0	185	22	185	0	109	0	0	0
RTOR Reduction (vph)	0	0	0	0	3	0	0	0	91	0	0	0
Lane Group Flow (vph)	630	141	0	0	204	0	185	0	18	0	0	0
Heavy Vehicles (%)	2%	3%	0%	0%	3%	0%	2%	0%	4%	0%	0%	0%
Turn Type	pm+pt						custom		custom			
Protected Phases	7	4			8							
Permitted Phases	4						2		2			
Actuated Green, G (s)	65.5	65.5			39.6		14.5		14.5			
Effective Green, g (s)	65.5	65.5			39.6		14.5		14.5			
Actuated g/C Ratio	0.73	0.73			0.44		0.16		0.16			
Clearance Time (s)	5.0	5.0			5.0		5.0		5.0			
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Lane Grp Cap (vph)	906	1343			803		285		250			
v/s Ratio Prot	c0.16	0.08			0.11							
v/s Ratio Perm	c0.34						c0.10		0.01			
v/c Ratio	0.70	0.10			0.25		0.65		0.07			
Uniform Delay, d1	5.7	3.6			15.9		35.4		32.0			
Progression Factor	0.59	0.30			0.67		1.00		1.00			
Incremental Delay, d2	1.9	0.1			0.2		5.0		0.1			
Delay (s)	5.2	1.2			10.9		40.4		32.2			
Level of Service	A	A			B		D		C			
Approach Delay (s)		4.5			10.9			37.3			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	13.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)

40: 199th Street & East Waverley — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	220	10	5	170	10	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	239	11	5	185	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	820					
pX, platoon unblocked						
vC, conflicting volume			250		440	245
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			250		440	245
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	99
cM capacity (veh/h)			1327		576	799

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	250	190	16
Volume Left	0	5	11
Volume Right	11	0	5
cSH	1700	1327	635
Volume to Capacity	0.15	0.00	0.03
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.3	10.8
Lane LOS		A	B
Approach Delay (s)	0.0	0.3	10.8
Approach LOS			B

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	23.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study
2030 Wellsville Alternative Action - (Improved+Mitigated)

1: 175th Street & Waverly Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	20	570	5	10	10	310	240	5	20	160	50
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.86		1.00	0.92		1.00	1.00		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1736	1678		1805	1850		1770	3497		1805	3331	
Flt Permitted	0.74	1.00		0.29	1.00		0.61	1.00		0.59	1.00	
Satd. Flow (perm)	1357	1678		551	1850		1143	3497		1125	3331	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	21	600	5	11	11	326	253	5	21	168	53
RTOR Reduction (vph)	0	508	0	0	9	0	0	1	0	0	18	0
Lane Group Flow (vph)	74	113	0	5	13	0	326	257	0	21	203	0
Heavy Vehicles (%)	4%	0%	2%	0%	0%	0%	2%	3%	0%	0%	4%	6%
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	13.8	13.8		13.8	13.8		66.2	59.2		54.5	52.5	
Effective Green, g (s)	13.8	13.8		13.8	13.8		66.2	59.2		54.5	52.5	
Actuated g/C Ratio	0.15	0.15		0.15	0.15		0.74	0.66		0.61	0.58	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	208	257		84	284		901	2300		696	1943	
v/s Ratio Prot		c0.07			0.01		c0.03	0.07		0.00	0.06	
v/s Ratio Perm	0.05			0.01			c0.23			0.02		
v/c Ratio	0.36	0.44		0.06	0.04		0.36	0.11		0.03	0.10	
Uniform Delay, d1	34.1	34.6		32.6	32.5		4.4	5.7		7.1	8.3	
Progression Factor	1.00	1.00		1.00	1.00		0.49	0.42		1.00	1.00	
Incremental Delay, d2	1.0	1.2		0.3	0.1		0.2	0.1		0.0	0.1	
Delay (s)	35.2	35.8		32.9	32.5		2.4	2.5		7.2	8.4	
Level of Service	D	D		C	C		A	A		A	A	
Approach Delay (s)		35.7			32.6			2.4			8.3	
Approach LOS		D			C			A			A	

Intersection Summary			
HCM Average Control Delay	18.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.37		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	70.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
2030 Wellsville Alternative Action - (Improved+Mitigated)

2: US 56 & Gardner Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	150	790	60	180	440	220	80	1040	310	370	850	140
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1752	3619	1583	1687	3519	1538	1752	3689	1553	3367	3435	
Flt Permitted	0.41	1.00	1.00	0.16	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	764	3619	1583	284	3519	1538	1752	3689	1553	3367	3435	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	158	832	63	189	463	232	84	1095	326	389	895	147
RTOR Reduction (vph)	0	0	42	0	0	168	0	0	119	0	14	0
Lane Group Flow (vph)	158	832	21	189	463	64	84	1095	207	389	1028	0
Heavy Vehicles (%)	3%	5%	2%	7%	8%	5%	3%	3%	4%	4%	3%	2%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			
Actuated Green, G (s)	30.9	24.3	24.3	32.3	25.0	25.0	6.0	29.7	29.7	12.0	35.7	
Effective Green, g (s)	30.9	24.3	24.3	32.3	25.0	25.0	6.0	29.7	29.7	12.0	35.7	
Actuated g/C Ratio	0.34	0.27	0.27	0.36	0.28	0.28	0.07	0.33	0.33	0.13	0.40	
Clearance Time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	335	977	427	216	978	427	117	1217	512	449	1363	
v/s Ratio Prot	0.03	0.23		c0.07	0.13		0.05	c0.30		c0.12	0.30	
v/s Ratio Perm	0.13		0.01	c0.24		0.04			0.13			
v/c Ratio	0.47	0.85	0.05	0.88	0.47	0.15	0.72	0.90	0.40	0.87	0.75	
Uniform Delay, d1	21.4	31.1	24.3	22.7	27.0	24.5	41.2	28.7	23.3	38.2	23.4	
Progression Factor	0.47	0.60	0.35	1.35	1.07	2.63	0.72	0.58	0.23	1.00	1.00	
Incremental Delay, d2	1.0	8.7	0.2	28.9	1.6	0.7	12.7	6.2	0.3	15.9	2.4	
Delay (s)	11.1	27.3	8.7	59.5	30.4	65.1	42.5	22.9	5.6	54.2	25.8	
Level of Service	B	C	A	E	C	E	D	C	A	D	C	
Approach Delay (s)		23.8			45.7			20.2			33.5	
Approach LOS		C			D			C			C	

Intersection Summary			
HCM Average Control Delay	29.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	13.3
Intersection Capacity Utilization	85.0%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
2030 Wellsville Alternative Action - (Improved+Mitigated)

8: US-56 & I-35 SB Ramps

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	2770	100	330	1450	0	0	0	0	210	0	1400
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		0.99		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3506		1719	3725					1736		2760
Flt Permitted		1.00		0.11	1.00					0.95		1.00
Satd. Flow (perm)		3506		207	3725					1736		2760
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2916	105	347	1526	0	0	0	0	221	0	1474
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	8
Lane Group Flow (vph)	0	3019	0	347	1526	0	0	0	0	221	0	1466
Heavy Vehicles (%)	0%	2%	14%	5%	2%	0%	0%	0%	0%	4%	0%	3%
Turn Type				pm+pt						custom		custom
Protected Phases		2		1	6					4		5
Permitted Phases				6						4		4
Actuated Green, G (s)		77.0		50.9	50.9					12.0		54.1
Effective Green, g (s)		77.0		50.9	50.9					12.0		54.1
Actuated g/C Ratio		0.64		0.42	0.42					0.10		0.45
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2250		289	1580					174		1359
v/s Ratio Prot		c0.86		c0.16	0.41					0.13		c0.38
v/s Ratio Perm				0.35								0.15
v/c Ratio		1.34		1.20	0.97					1.27		1.08
Uniform Delay, d1		21.5		35.5	33.7					54.0		32.9
Progression Factor		0.71		0.90	0.87					1.00		1.00
Incremental Delay, d2		154.7		110.5	11.5					158.8		48.7
Delay (s)		169.9		142.3	40.8					212.8		81.7
Level of Service		F		F	D					F		F
Approach Delay (s)		169.9			59.6			0.0			98.8	
Approach LOS		F			E			A			F	

Intersection Summary			
HCM Average Control Delay	120.2	HCM Level of Service	F
HCM Volume to Capacity ratio	1.26		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	121.3%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study
2030 Wellsville Alternative Action - (Improved+Mitigated)

9: US-56 & I-35 NB Ramps

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1300	0	0	1610	550	170	0	730	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95	0.95			
Frt		1.00			1.00	0.85	1.00	0.85	0.85			
Flt Protected		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (prot)		3725			3539	1583	1671	1490	1490			
Flt Permitted		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (perm)		3725			3539	1583	1671	1490	1490			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1368	0	0	1695	579	179	0	768	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	121	0	0	0	0	0	0
Lane Group Flow (vph)	0	1368	0	0	1695	458	179	384	384	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	2%	8%	0%	3%	0%	0%	0%
Turn Type						Perm	Perm		Perm			
Protected Phases		2			6			8				
Permitted Phases						6	8		8			
Actuated Green, G (s)		74.0			74.0	74.0	36.0	36.0	36.0			
Effective Green, g (s)		74.0			74.0	74.0	36.0	36.0	36.0			
Actuated g/C Ratio		0.62			0.62	0.62	0.30	0.30	0.30			
Clearance Time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0	3.0			
Lane Grp Cap (vph)		2297			2182	976	501	447	447			
v/s Ratio Prot		0.37			c0.48			c0.26				
v/s Ratio Perm						0.29	0.11		0.26			
v/c Ratio		0.60			0.78	0.47	0.36	0.86	0.86			
Uniform Delay, d1		13.9			16.9	12.4	32.9	39.6	39.6			
Progression Factor		0.50			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2		0.1			1.8	0.4	0.4	15.1	15.1			
Delay (s)		7.0			18.7	12.8	33.4	54.7	54.7			
Level of Service		A			B	B	C	D	D			
Approach Delay (s)		7.0			17.2			50.7			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	21.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	106.7%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

2030 Wellsville North Alternative - (Improved + Mitigated) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

11: Waverly Road & US 56

AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	110	10	560	110	60	90	210	0	10	120	360
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor		0.95	1.00	0.97	0.95		1.00	0.95		1.00	0.95	1.00
Frt		1.00	0.85	1.00	0.95		1.00	1.00		1.00	1.00	0.85
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)		3539	1615	3400	3296		1752	3343		1805	3112	1568
Flt Permitted		1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)		3539	1615	3400	3296		1752	3343		1805	3112	1568
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	116	11	589	116	63	95	221	0	11	126	379
RTOR Reduction (vph)	0	0	10	0	39	0	0	0	0	0	0	244
Lane Group Flow (vph)	0	116	1	589	140	0	95	221	0	11	126	135
Heavy Vehicles (%)	0%	2%	0%	3%	2%	7%	3%	8%	0%	0%	16%	3%
Turn Type	Prot		Perm	Prot			Prot		Perm	Prot		Perm
Protected Phases	3	8		7	4		5	2		1	6	
Permitted Phases			8					2	2			6
Actuated Green, G (s)		8.3	8.3	20.7	34.0		8.9	39.5		1.5	32.1	32.1
Effective Green, g (s)		8.3	8.3	20.7	34.0		8.9	39.5		1.5	32.1	32.1
Actuated g/C Ratio		0.09	0.09	0.23	0.38		0.10	0.44		0.02	0.36	0.36
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)		326	149	782	1245		173	1467		30	1110	559
v/s Ratio Prot		c0.03		c0.17	0.04		c0.05	0.07		0.01	0.04	
v/s Ratio Perm			0.00									c0.09
v/c Ratio		0.36	0.01	0.75	0.11		0.55	0.15		0.37	0.11	0.24
Uniform Delay, d1		38.3	37.1	32.3	18.2		38.6	15.2		43.8	19.4	20.4
Progression Factor		1.01	1.02	0.94	0.84		1.00	1.00		1.27	0.61	0.94
Incremental Delay, d2		0.7	0.0	3.7	0.0		3.5	0.2		6.4	0.2	0.9
Delay (s)		39.3	37.7	34.1	15.2		42.2	15.4		61.9	12.0	20.0
Level of Service		D	D	C	B		D	B		E	B	C
Approach Delay (s)		39.1			29.7			23.4			18.9	
Approach LOS		D			C			C			B	

Intersection Summary			
HCM Average Control Delay	26.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	43.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

13: 183rd Street & US 56

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	20	20	5	30	20	5	0	280	30	5	150	30
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	21	5	32	21	5	0	295	32	5	158	32
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	511	511	174	511	511	311	189			326		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	511	511	174	511	511	311	189			326		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	95	95	99	93	95	99	100			100		
cM capacity (veh/h)	456	467	875	456	467	734	1397			1245		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	47	58	326	195
Volume Left	21	32	0	5
Volume Right	5	5	32	32
cSH	487	477	1397	1245
Volume to Capacity	0.10	0.12	0.00	0.00
Queue Length 95th (ft)	8	10	0	0
Control Delay (s)	13.2	13.6	0.0	0.3
Lane LOS	B	B		A
Approach Delay (s)	13.2	13.6	0.0	0.3
Approach LOS	B	B		

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	27.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

16: Four Corners Road & US 56

AM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	110	70	0	140	50	30	240	0	60	120	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	116	74	0	147	53	32	253	0	63	126	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	695	568	253	700	568	126	126			253		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	695	568	253	700	568	126	126			253		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	71	91	100	63	94	98			95		
cM capacity (veh/h)	231	402	788	239	402	924	1454			1313		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	195	200	284	189
Volume Left	5	0	32	63
Volume Right	74	53	0	0
cSH	482	473	1454	1313
Volume to Capacity	0.40	0.42	0.02	0.05
Queue Length 95th (ft)	48	52	2	4
Control Delay (s)	17.4	18.1	1.0	2.9
Lane LOS	C	C	A	A
Approach Delay (s)	17.4	18.1	1.0	2.9
Approach LOS	C	C		

Intersection Summary			
Average Delay	9.0		
Intersection Capacity Utilization	42.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

17: 191st Street & US 56

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	20	10	5	5	10	5	0	250	10	0	110	60
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	11	5	5	11	5	0	263	11	0	116	63
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	426	421	147	426	447	268	179			274		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	426	421	147	426	447	268	179			274		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	96	98	99	99	98	99	100			100		
cM capacity (veh/h)	530	527	905	531	509	775	1409			1301		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	37	21	274	179
Volume Left	21	5	0	0
Volume Right	5	5	11	63
cSH	562	563	1409	1301
Volume to Capacity	0.07	0.04	0.00	0.00
Queue Length 95th (ft)	5	3	0	0
Control Delay (s)	11.9	11.6	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	11.9	11.6	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	1.3		
Intersection Capacity Utilization	24.4%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Wellsville North Alternative - (Improved + Mitigated) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

24: Sunflower Road & US 56 — AM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	5	20	5	280	30	5	5	250	370	5	110	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.98			1.00			0.92			1.00	
Flt Protected		0.99			0.96			1.00			1.00	
Satd. Flow (prot)		1844			1708			1677			1686	
Flt Permitted		0.94			0.73			1.00			0.98	
Satd. Flow (perm)		1748			1297			1676			1653	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	5	21	5	295	32	5	5	263	389	5	116	0
RTOR Reduction (vph)	0	3	0	0	1	0	0	89	0	0	0	0
Lane Group Flow (vph)	0	28	0	0	331	0	0	568	0	0	121	0
Heavy Vehicles (%)	0%	0%	0%	7%	1%	0%	0%	6%	3%	0%	13%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		17.1			17.1			27.9			27.9	
Effective Green, g (s)		17.1			17.1			27.9			27.9	
Actuated g/C Ratio		0.31			0.31			0.51			0.51	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		543			403			850			839	
v/s Ratio Prot												
v/s Ratio Perm		0.02			c0.25			c0.34			0.07	
v/c Ratio		0.05			0.82			0.67			0.14	
Uniform Delay, d1		13.3			17.5			10.1			7.2	
Progression Factor		1.00			1.00			0.72			1.00	
Incremental Delay, d2		0.0			12.6			3.4			0.4	
Delay (s)		13.3			30.1			10.7			7.6	
Level of Service		B			C			B			A	
Approach Delay (s)		13.3			30.1			10.7			7.6	
Approach LOS		B			C			B			A	

Intersection Summary			
HCM Average Control Delay	16.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	55.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	70.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

25: US 56 & 4th Street — AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	540	130	80	310	110	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0			5.0	5.0	
Lane Util. Factor	1.00			1.00	1.00	
Frt	0.97			1.00	0.94	
Flt Protected	1.00			0.99	0.97	
Satd. Flow (prot)	1782			1781	1672	
Flt Permitted	1.00			0.79	0.97	
Satd. Flow (perm)	1782			1421	1672	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	568	137	84	326	116	84
RTOR Reduction (vph)	12	0	0	0	55	0
Lane Group Flow (vph)	693	0	0	410	145	0
Heavy Vehicles (%)	4%	3%	4%	6%	5%	3%
Turn Type			Perm			
Protected Phases	4			8	2	
Permitted Phases			8			
Actuated Green, G (s)	35.1			35.1	9.9	
Effective Green, g (s)	35.1			35.1	9.9	
Actuated g/C Ratio	0.64			0.64	0.18	
Clearance Time (s)	5.0			5.0	5.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	1137			907	301	
v/s Ratio Prot	c0.39				c0.09	
v/s Ratio Perm				0.29		
v/c Ratio	0.61			0.45	0.48	
Uniform Delay, d1	5.9			5.1	20.2	
Progression Factor	0.80			1.92	1.00	
Incremental Delay, d2	2.2			1.4	1.2	
Delay (s)	7.0			11.0	21.5	
Level of Service	A			B	C	
Approach Delay (s)	7.0			11.0	21.5	
Approach LOS	A			B	C	

Intersection Summary			
HCM Average Control Delay	10.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	55.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	80.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

28: I-35 SB Ramps & Sunflower Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	20	0	320	5	190	0	0	800	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0	5.0			5.0			5.0	
Lane Util. Factor				1.00	1.00			1.00			1.00	
Frt				1.00	0.85			1.00			0.99	
Flt Protected				0.95	1.00			1.00			1.00	
Satd. Flow (prot)				1641	1205			1745			1566	
Flt Permitted				0.95	1.00			0.98			1.00	
Satd. Flow (perm)				1641	1205			1719			1566	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	21	0	337	5	200	0	0	842	95
RTOR Reduction (vph)	0	0	0	0	312	0	0	0	0	0	3	0
Lane Group Flow (vph)	0	0	0	21	25	0	0	205	0	0	934	0
Heavy Vehicles (%)	0%	0%	0%	10%	0%	34%	0%	9%	0%	0%	21%	8%
Turn Type				custom			Perm					
Protected Phases				6	6			8			4	
Permitted Phases				6			8					
Actuated Green, G (s)				6.8	6.8			73.2			73.2	
Effective Green, g (s)				6.8	6.8			73.2			73.2	
Actuated g/C Ratio				0.08	0.08			0.81			0.81	
Clearance Time (s)				5.0	5.0			5.0			5.0	
Vehicle Extension (s)				3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)				124	91			1398			1274	
v/s Ratio Prot				0.01	c0.02						c0.60	
v/s Ratio Perm								0.12				
v/c Ratio				0.17	0.28			0.15			0.73	
Uniform Delay, d1				39.0	39.3			1.8			3.9	
Progression Factor				1.00	1.00			0.78			1.00	
Incremental Delay, d2				0.6	1.7			0.2			3.8	
Delay (s)				39.6	41.0			1.6			7.6	
Level of Service				D	D			A			A	
Approach Delay (s)		0.0			40.9			1.6			7.6	
Approach LOS		A			D			A			A	

Intersection Summary			
HCM Average Control Delay	14.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	75.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

29: I-35 NB Ramps & Sunflower Road — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	160	0	5	0	0	0	0	40	110	790	40	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0	5.0		5.0	
Lane Util. Factor		1.00						1.00	1.00		1.00	
Frt		1.00						1.00	0.85		1.00	
Flt Protected		0.95						1.00	1.00		0.95	
Satd. Flow (prot)		1675						1759	1583		1495	
Flt Permitted		0.95						1.00	1.00		0.71	
Satd. Flow (perm)		1675						1759	1583		1105	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	168	0	5	0	0	0	0	42	116	832	42	0
RTOR Reduction (vph)	0	1	0	0	0	0	0	0	30	0	0	0
Lane Group Flow (vph)	0	172	0	0	0	0	0	42	86	0	874	0
Heavy Vehicles (%)	8%	0%	0%	0%	0%	0%	0%	8%	2%	22%	8%	0%
Turn Type	Perm								Perm	Perm		
Protected Phases		2						8			4	
Permitted Phases	2								8	4		
Actuated Green, G (s)		13.5						66.5	66.5		66.5	
Effective Green, g (s)		13.5						66.5	66.5		66.5	
Actuated g/C Ratio		0.15						0.74	0.74		0.74	
Clearance Time (s)		5.0						5.0	5.0		5.0	
Vehicle Extension (s)		3.0						3.0	3.0		3.0	
Lane Grp Cap (vph)		251						1300	1170		816	
v/s Ratio Prot								0.02				
v/s Ratio Perm		0.10							0.05		c0.79	
v/c Ratio		0.69						0.03	0.07		1.07	
Uniform Delay, d1		36.2						3.1	3.2		11.7	
Progression Factor		1.00						1.00	1.00		1.16	
Incremental Delay, d2		7.6						0.0	0.1		47.5	
Delay (s)		43.8						3.2	3.4		61.1	
Level of Service		D						A	A		E	
Approach Delay (s)		43.8			0.0			3.3			61.1	
Approach LOS		D			A			A			E	

Intersection Summary			
HCM Average Control Delay	51.0	HCM Level of Service	D
HCM Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	74.3%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

2030 Wellsville North Alternative - (Improved + Mitigated) - AM Peak Hour - Synchro Intersection LOS

31: US 56 & Edgerton Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	5	420	40	100	170	80	40	100	140	40	50	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0			5.0			5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Frt	1.00	0.99		1.00	0.95			0.93			1.00	
Flt Protected	0.95	1.00		0.95	1.00			0.99			0.98	
Satd. Flow (prot)	1805	1813		1671	1722			1541			1795	
Flt Permitted	0.59	1.00		0.43	1.00			0.94			0.71	
Satd. Flow (perm)	1125	1813		748	1722			1459			1298	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	5	457	43	109	185	87	42	105	152	43	53	0
RTOR Reduction (vph)	0	5	0	0	26	0	0	76	0	0	0	0
Lane Group Flow (vph)	5	495	0	109	246	0	0	223	0	0	96	0
Heavy Vehicles (%)	0%	3%	8%	8%	6%	3%	18%	24%	6%	3%	4%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	32.4	32.4		32.4	32.4			12.6			12.6	
Effective Green, g (s)	32.4	32.4		32.4	32.4			12.6			12.6	
Actuated g/C Ratio	0.59	0.59		0.59	0.59			0.23			0.23	
Clearance Time (s)	5.0	5.0		5.0	5.0			5.0			5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	663	1068		441	1014			334			297	
v/s Ratio Prot		c0.27			0.14							
v/s Ratio Perm	0.00			0.15				c0.15			0.07	
v/c Ratio	0.01	0.46		0.25	0.24			0.67			0.32	
Uniform Delay, d1	4.7	6.4		5.4	5.4			19.3			17.7	
Progression Factor	1.00	1.00		0.87	0.97			1.00			1.00	
Incremental Delay, d2	0.0	1.4		1.2	0.5			5.0			0.6	
Delay (s)	4.7	7.8		6.0	5.8			24.3			18.3	
Level of Service	A	A		A	A			C			B	
Approach Delay (s)		7.8			5.9			24.3			18.3	
Approach LOS		A			A			C			B	

Intersection Summary			
HCM Average Control Delay	11.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	55.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	59.2%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

32: 207th & Sunflower Road

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	0	460	5	0	10	310	260	0	5	290	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	0	582	6	0	13	392	329	0	6	367	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1509	1497	370	2079	1500	329	373			329		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1509	1497	370	2079	1500	329	373			329		
tC, single (s)	7.1	6.5	6.6	7.1	6.5	6.2	4.5			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.6	3.5	4.0	3.3	2.5			2.2		
p0 queue free %	91	100	4	0	100	98	61			99		
cM capacity (veh/h)	68	76	604	1	75	717	1016			1242		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	589	19	722	380
Volume Left	6	6	392	6
Volume Right	582	13	0	6
cSH	557	3	1016	1242
Volume to Capacity	1.06	6.32	0.39	0.01
Queue Length 95th (ft)	424	Err	46	0
Control Delay (s)	80.9	Err	8.2	0.2
Lane LOS	F	F	A	A
Approach Delay (s)	80.9	Err	8.2	0.2
Approach LOS	F	F		

Intersection Summary			
Average Delay	142.5		
Intersection Capacity Utilization	85.6%	ICU Level of Service	E
Analysis Period (min)	15		

33: 207th & COOP Rd

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	20	390	290	10	60	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	27	527	392	14	81	14
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	405				980	399
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	405				980	399
tC, single (s)	4.1				6.4	6.5
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.6
p0 queue free %	98				70	98
cM capacity (veh/h)	1164				271	594

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	554	405	95
Volume Left	27	0	81
Volume Right	0	14	14
cSH	1164	1700	294
Volume to Capacity	0.02	0.24	0.32
Queue Length 95th (ft)	2	0	34
Control Delay (s)	0.7	0.0	23.0
Lane LOS	A		C
Approach Delay (s)	0.7	0.0	23.0
Approach LOS			C

Intersection Summary			
Average Delay	2.4		
Intersection Capacity Utilization	47.4%	ICU Level of Service	A
Analysis Period (min)	15		

34: 207th & Edgerton Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	250	0	0	190	120	0	10	0	160	5	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		1.00			0.95			1.00			0.96	
Flt Protected		0.99			1.00			1.00			0.97	
Satd. Flow (prot)		1224			1288			1583			1671	
Flt Permitted		0.78			1.00			1.00			0.79	
Satd. Flow (perm)		965			1288			1583			1360	
Peak-hour factor, PHF	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Adj. Flow (vph)	121	379	0	0	288	182	0	15	0	242	8	106
RTOR Reduction (vph)	0	0	0	0	36	0	0	0	0	0	23	0
Lane Group Flow (vph)	0	500	0	0	434	0	0	15	0	0	333	0
Heavy Vehicles (%)	14%	66%	0%	0%	58%	11%	0%	20%	0%	2%	40%	11%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		34.3			34.3			17.1			17.1	
Effective Green, g (s)		34.3			34.3			17.1			17.1	
Actuated g/C Ratio		0.56			0.56			0.28			0.28	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		539			720			441			379	
v/s Ratio Prot					0.34			0.01				
v/s Ratio Perm		c0.52									c0.24	
v/c Ratio		0.93			0.60			0.03			0.88	
Uniform Delay, d1		12.4			9.0			16.1			21.2	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		22.2			1.4			0.0			19.9	
Delay (s)		34.6			10.5			16.2			41.1	
Level of Service		C			B			B			D	
Approach Delay (s)		34.6			10.5			16.2			41.1	
Approach LOS		C			B			B			D	

Intersection Summary			
HCM Average Control Delay	27.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	61.4	Sum of lost time (s)	10.0
Intersection Capacity Utilization	67.5%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

35: 207th & Evening Star Rd

AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	10	0	250	10	0	310
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	20	0	500	20	0	620
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			20		1040	20
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			20		1040	20
tC, single (s)			4.6		6.4	6.8
tC, 2 stage (s)						
tF (s)			2.6		3.5	3.8
p0 queue free %			63		100	33
cM capacity (veh/h)			1348		162	919

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	20	520	620
Volume Left	0	500	0
Volume Right	0	0	620
cSH	1700	1348	919
Volume to Capacity	0.01	0.37	0.67
Queue Length 95th (ft)	0	44	136
Control Delay (s)	0.0	9.0	16.6
Lane LOS		A	C
Approach Delay (s)	0.0	9.0	16.6
Approach LOS			C

Intersection Summary			
Average Delay	12.9		
Intersection Capacity Utilization	46.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

36: 215th & Evening Star Rd

AM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	10	10	300	250	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	20	20	600	500	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	620				40	20
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	620				40	20
tC, single (s)	4.1				6.9	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.9	3.3
p0 queue free %	100				42	99
cM capacity (veh/h)	970				869	1064

Direction, Lane #	EB 1	WB 1	WB 2	SB 1
Volume Total	20	20	600	510
Volume Left	0	0	0	500
Volume Right	0	0	600	10
cSH	970	1700	1700	872
Volume to Capacity	0.00	0.01	0.35	0.58
Queue Length 95th (ft)	0	0	0	97
Control Delay (s)	0.0	0.0	0.0	14.8
Lane LOS				B
Approach Delay (s)	0.0	0.0		14.8
Approach LOS				B

Intersection Summary			
Average Delay	6.6		
Intersection Capacity Utilization	28.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

37: 199th Street & West Waverley

AM Peak Hour

Movement	EBL	EBT	WBU	WBT	WBR	SBL	SBR
Lane Configurations							
Volume (veh/h)	10	740	0	680	60	30	10
Sign Control		Free		Free		Stop	
Grade		0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	804	0	739	65	33	11
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type		TWLTL		TWLTL			
Median storage veh)		2		2			
Upstream signal (ft)				802			
pX, platoon unblocked			0.00				
vC, conflicting volume	804		0			1598	772
vC1, stage 1 conf vol						772	
vC2, stage 2 conf vol						826	
vCu, unblocked vol	804		0			1598	772
tC, single (s)	4.1		0.0			6.4	6.2
tC, 2 stage (s)						5.4	
tF (s)	2.2		0.0			3.5	3.3
p0 queue free %	99		0			90	97
cM capacity (veh/h)	829		0			322	403

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	11	804	804	0	43
Volume Left	11	0	0	0	33
Volume Right	0	0	65	0	11
cSH	829	1700	1700	1700	339
Volume to Capacity	0.01	0.47	0.47	0.00	0.13
Queue Length 95th (ft)	1	0	0	0	11
Control Delay (s)	9.4	0.0	0.0	0.0	17.2
Lane LOS	A				C
Approach Delay (s)	0.1		0.0		17.2
Approach LOS					C

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	49.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

38: 199th Street & IH-35 SB Ramp

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	710	60	60	280	0	0	0	0	10	0	460
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		1.00		1.00	1.00					1.00		1.00
Frt		0.99		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		1843		1719	1845					1805		1583
Flt Permitted		1.00		0.25	1.00					0.95		1.00
Satd. Flow (perm)		1843		457	1845					1805		1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	772	65	65	304	0	0	0	0	11	0	500
RTOR Reduction (vph)	0	3	0	0	0	0	0	0	0	0	0	472
Lane Group Flow (vph)	0	834	0	65	304	0	0	0	0	11	0	28
Heavy Vehicles (%)	0%	2%	2%	5%	3%	0%	0%	0%	0%	0%	0%	2%
Turn Type				pm+pt						Prot		custom
Protected Phases		4		3	8					6		
Permitted Phases				8								6
Actuated Green, G (s)		66.8		75.0	75.0					5.0		5.0
Effective Green, g (s)		66.8		75.0	75.0					5.0		5.0
Actuated g/C Ratio		0.74		0.83	0.83					0.06		0.06
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		1368		426	1538					100		88
v/s Ratio Prot		c0.45		0.01	c0.16					0.01		
v/s Ratio Perm				0.12								c0.02
v/c Ratio		0.61		0.15	0.20					0.11		0.32
Uniform Delay, d1		5.5		3.8	1.5					40.4		40.9
Progression Factor		1.00		1.18	1.35					1.00		1.00
Incremental Delay, d2		2.0		0.2	0.1					0.5		2.1
Delay (s)		7.5		4.7	2.1					40.9		42.9
Level of Service		A		A	A					D		D
Approach Delay (s)		7.5			2.5			0.0			42.9	
Approach LOS		A			A			A			D	

Intersection Summary			
HCM Average Control Delay	17.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	64.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

2030 Wellsville North Alternative - (Improved + Mitigated) - AM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

39: 199th Street & IH-35 NB Ramp

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	580	130	0	0	170	20	170	0	100	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0		5.0			
Lane Util. Factor	1.00	1.00			1.00		1.00		1.00			
Frt	1.00	1.00			0.99		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1770	1845			1824		1770		1553			
Flt Permitted	0.54	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	998	1845			1824		1770		1553			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	630	141	0	0	185	22	185	0	109	0	0	0
RTOR Reduction (vph)	0	0	0	0	3	0	0	0	91	0	0	0
Lane Group Flow (vph)	630	141	0	0	204	0	185	0	18	0	0	0
Heavy Vehicles (%)	2%	3%	0%	0%	3%	0%	2%	0%	4%	0%	0%	0%
Turn Type	pm+pt						custom		custom			
Protected Phases	7	4			8							
Permitted Phases	4						2		2			
Actuated Green, G (s)	65.5	65.5			39.6		14.5		14.5			
Effective Green, g (s)	65.5	65.5			39.6		14.5		14.5			
Actuated g/C Ratio	0.73	0.73			0.44		0.16		0.16			
Clearance Time (s)	5.0	5.0			5.0		5.0		5.0			
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Lane Grp Cap (vph)	906	1343			803		285		250			
v/s Ratio Prot	c0.16	0.08			0.11							
v/s Ratio Perm	c0.34						c0.10		0.01			
v/c Ratio	0.70	0.10			0.25		0.65		0.07			
Uniform Delay, d1	5.7	3.6			15.9		35.4		32.0			
Progression Factor	0.40	0.27			0.67		1.00		1.00			
Incremental Delay, d2	1.9	0.1			0.2		5.0		0.1			
Delay (s)	4.2	1.1			10.9		40.4		32.2			
Level of Service	A	A			B		D		C			
Approach Delay (s)		3.6			10.9			37.3			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	12.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

40: 199th Street & East Waverley

AM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	220	10	5	170	10	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	239	11	5	185	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	820					
pX, platoon unblocked						
vC, conflicting volume			250		440	245
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			250		440	245
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	99
cM capacity (veh/h)			1327		576	799

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	250	190	16
Volume Left	0	5	11
Volume Right	11	0	5
cSH	1700	1327	635
Volume to Capacity	0.15	0.00	0.03
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.3	10.8
Lane LOS		A	B
Approach Delay (s)	0.0	0.3	10.8
Approach LOS			B

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	23.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)

1: 175th Street & Waverly Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	10	330	0	20	30	630	220	0	10	130	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00			1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85			0.91		1.00	1.00		1.00	0.96	
Flt Protected	0.95	1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1677			1819		1770	3539		1805	3407	
Flt Permitted	0.72	1.00			1.00		0.64	1.00		0.61	1.00	
Satd. Flow (perm)	1346	1677			1819		1190	3539		1154	3407	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	53	11	347	0	21	32	663	232	0	11	137	42
RTOR Reduction (vph)	0	309	0	0	29	0	0	0	0	0	20	0
Lane Group Flow (vph)	53	49	0	0	24	0	663	232	0	11	159	0
Heavy Vehicles (%)	2%	0%	2%	0%	0%	0%	2%	2%	0%	0%	2%	3%
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	9.8	9.8			9.8		70.2	61.9		51.1	47.8	
Effective Green, g (s)	9.8	9.8			9.8		70.2	61.9		51.1	47.8	
Actuated g/C Ratio	0.11	0.11			0.11		0.78	0.69		0.57	0.53	
Clearance Time (s)	5.0	5.0			5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	147	183			198		1040	2434		679	1809	
v/s Ratio Prot		0.03			0.01		c0.12	0.07		0.00	0.05	
v/s Ratio Perm	c0.04						c0.37			0.01		
v/c Ratio	0.36	0.27			0.12		0.64	0.10		0.02	0.09	
Uniform Delay, d1	37.2	36.8			36.2		4.9	4.7		8.5	10.4	
Progression Factor	1.00	1.00			1.00		0.58	0.76		1.00	1.00	
Incremental Delay, d2	1.5	0.8			0.3		1.1	0.1		0.0	0.1	
Delay (s)	38.7	37.6			36.5		4.0	3.6		8.5	10.5	
Level of Service	D	D			D		A	A		A	B	
Approach Delay (s)		37.7			36.5			3.9			10.4	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM Average Control Delay	14.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	72.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)

2: US 56 & Gardner Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	130	440	60	300	900	440	50	890	220	320	930	120
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1736	3519	1583	1770	3689	1583	1770	3725	1568	3400	3475	
Flt Permitted	0.16	1.00	1.00	0.39	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	290	3519	1583	724	3689	1583	1770	3725	1568	3400	3475	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	463	63	316	947	463	53	937	232	337	979	126
RTOR Reduction (vph)	0	0	45	0	0	253	0	0	157	0	11	0
Lane Group Flow (vph)	137	463	18	316	947	210	53	937	75	337	1094	0
Heavy Vehicles (%)	4%	8%	2%	2%	3%	2%	2%	2%	3%	3%	2%	3%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			
Actuated Green, G (s)	31.8	25.2	25.2	33.8	26.2	26.2	3.9	29.2	29.2	11.3	36.6	
Effective Green, g (s)	31.8	25.2	25.2	33.8	26.2	26.2	3.9	29.2	29.2	11.3	36.6	
Actuated g/C Ratio	0.35	0.28	0.28	0.38	0.29	0.29	0.04	0.32	0.32	0.13	0.41	
Clearance Time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	209	985	443	360	1074	461	77	1209	509	427	1413	
v/s Ratio Prot	0.05	0.13		c0.07	c0.26		c0.03	c0.25		c0.10	0.31	
v/s Ratio Perm	0.18		0.01	0.26		0.13			0.05			
v/c Ratio	0.66	0.47	0.04	0.88	0.88	0.46	0.69	0.78	0.15	0.79	0.77	
Uniform Delay, d1	22.4	26.9	23.6	24.3	30.4	26.1	42.5	27.4	21.6	38.2	23.1	
Progression Factor	1.32	0.66	0.51	1.32	1.15	1.95	0.73	0.56	0.30	1.00	1.00	
Incremental Delay, d2	7.1	1.6	0.2	15.7	7.7	2.3	14.0	1.9	0.1	9.4	2.7	
Delay (s)	36.6	19.3	12.1	47.8	42.7	53.0	45.1	17.3	6.6	47.6	25.8	
Level of Service	D	B	B	D	D	D	D	B	A	D	C	
Approach Delay (s)		22.2			46.4			16.5			30.9	
Approach LOS		C			D			B			C	

Intersection Summary			
HCM Average Control Delay	31.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.8
Intersection Capacity Utilization	80.1%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)

8: US-56 & I-35 SB Ramps

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	2720	280	660	1250	0	0	0	0	170	0	1560
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		0.99		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3486		1736	3725					1770		2787
Flt Permitted		1.00		0.22	1.00					0.95		1.00
Satd. Flow (perm)		3486		395	3725					1770		2787
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2863	295	695	1316	0	0	0	0	179	0	1642
RTOR Reduction (vph)	0	6	0	0	0	0	0	0	0	0	0	7
Lane Group Flow (vph)	0	3152	0	695	1316	0	0	0	0	179	0	1635
Heavy Vehicles (%)	0%	2%	3%	4%	2%	0%	0%	0%	0%	2%	0%	2%
Turn Type				pm+pt						custom		custom
Protected Phases		2		1	6					4		5
Permitted Phases				6						4		4
Actuated Green, G (s)		69.0		44.5	44.5					10.0		60.5
Effective Green, g (s)		69.0		44.5	44.5					10.0		60.5
Actuated g/C Ratio		0.57		0.37	0.37					0.08		0.50
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2004		437	1381					148		1521
v/s Ratio Prot		c0.90		c0.34	0.35					0.10		c0.45
v/s Ratio Perm				c0.25								0.13
v/c Ratio		1.57		1.59	0.95					1.21		1.07
Uniform Delay, d1		25.5		34.4	36.7					55.0		29.8
Progression Factor		0.75		0.92	0.89					1.00		1.00
Incremental Delay, d2		257.9		273.0	10.9					141.2		46.0
Delay (s)		277.1		304.6	43.7					196.2		75.8
Level of Service		F		F	D					F		E
Approach Delay (s)		277.1			133.8			0.0			87.6	
Approach LOS		F			F			A			F	

Intersection Summary			
HCM Average Control Delay	186.5	HCM Level of Service	F
HCM Volume to Capacity ratio	1.43		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	5.0
Intersection Capacity Utilization	141.8%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)

9: US-56 & I-35 NB Ramps

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1530	0	0	1810	580	100	0	400	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95	0.95			
Frt		1.00			1.00	0.85	1.00	0.85	0.85			
Flt Protected		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (prot)		3725			3539	1538	1671	1408	1408			
Flt Permitted		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (perm)		3725			3539	1538	1671	1408	1408			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1611	0	0	1905	611	105	0	421	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	83	0	0	0	0	0	0
Lane Group Flow (vph)	0	1611	0	0	1905	528	105	211	210	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	5%	8%	0%	9%	0%	0%	0%
Turn Type						Perm	Perm		Perm			
Protected Phases		2			6			8				
Permitted Phases						6	8		8			
Actuated Green, G (s)		86.2			86.2	86.2	23.8	23.8	23.8			
Effective Green, g (s)		86.2			86.2	86.2	23.8	23.8	23.8			
Actuated g/C Ratio		0.72			0.72	0.72	0.20	0.20	0.20			
Clearance Time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0	3.0			
Lane Grp Cap (vph)		2676			2542	1105	331	279	279			
v/s Ratio Prot		0.43			c0.54			c0.15				
v/s Ratio Perm						0.34	0.06		0.15			
v/c Ratio		0.60			0.75	0.48	0.32	0.76	0.75			
Uniform Delay, d1		8.4			10.3	7.2	41.1	45.4	45.3			
Progression Factor		0.39			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2		0.1			1.2	0.3	0.6	11.1	10.9			
Delay (s)		3.4			11.6	7.6	41.7	56.5	56.2			
Level of Service		A			B	A	D	E	E			
Approach Delay (s)		3.4			10.6			53.4			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	12.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	86.9%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study | 2030 Wellsville Alternative Action - (Improved)
11: Waverly Road & US 56 | PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	150	20	310	110	40	60	130	0	30	200	630
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor		0.95	1.00	0.97	0.95		1.00	0.95		1.00	0.95	1.00
Frt		1.00	0.85	1.00	0.96		1.00	1.00		1.00	1.00	0.85
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)		3539	1615	3400	3372		1770	3167		1752	3343	1583
Flt Permitted		1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)		3539	1615	3400	3372		1770	3167		1752	3343	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	158	21	326	116	42	63	137	0	32	211	663
RTOR Reduction (vph)	0	0	19	0	29	0	0	0	0	0	0	374
Lane Group Flow (vph)	0	158	2	326	129	0	63	137	0	32	211	289
Heavy Vehicles (%)	0%	2%	0%	3%	2%	5%	2%	14%	0%	3%	8%	2%
Turn Type	Prot		Perm	Prot			Prot		Perm	Prot		Perm
Protected Phases	3	8		7	4		5	2		1	6	
Permitted Phases			8					2	2			6
Actuated Green, G (s)		9.4	9.4	13.9	28.3		7.5	41.8		4.9	39.2	39.2
Effective Green, g (s)		9.4	9.4	13.9	28.3		7.5	41.8		4.9	39.2	39.2
Actuated g/C Ratio		0.10	0.10	0.15	0.31		0.08	0.46		0.05	0.44	0.44
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)		370	169	525	1060		148	1471		95	1456	689
v/s Ratio Prot		c0.04		c0.10	0.04		c0.04	c0.04		0.02	0.06	
v/s Ratio Perm			0.00									c0.18
v/c Ratio		0.43	0.01	0.62	0.12		0.43	0.09		0.34	0.14	0.42
Uniform Delay, d1		37.8	36.1	35.6	22.0		39.2	13.5		41.0	15.3	17.5
Progression Factor		1.02	1.04	0.91	0.81		0.98	0.89		1.46	0.30	2.88
Incremental Delay, d2		0.8	0.0	2.2	0.1		2.0	0.1		1.1	0.1	1.0
Delay (s)		39.4	37.5	34.5	17.9		40.3	12.1		60.9	4.6	51.5
Level of Service		D	D	C	B		D	B		E	A	D
Approach Delay (s)		39.1			29.1			21.0			40.9	
Approach LOS		D			C			C			D	

Intersection Summary			
HCM Average Control Delay	35.2	HCM Level of Service	D
HCM Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	25.0
Intersection Capacity Utilization	59.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study | 2030 Wellsville Alternative Action - (Improved)
13: 183rd Street & US 56 | PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	40	20	5	20	50	5	0	170	30	5	210	20
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	42	21	5	21	53	5	0	179	32	5	221	21
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	468	453	232	453	447	195	242			211		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	468	453	232	453	447	195	242			211		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	91	96	99	96	90	99	100			100		
cM capacity (veh/h)	459	504	813	499	504	852	1336			1372		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	68	79	211	247
Volume Left	42	21	0	5
Volume Right	5	5	32	21
cSH	489	517	1336	1372
Volume to Capacity	0.14	0.15	0.00	0.00
Queue Length 95th (ft)	12	13	0	0
Control Delay (s)	13.6	13.2	0.0	0.2
Lane LOS	B	B		A
Approach Delay (s)	13.6	13.2	0.0	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	3.3		
Intersection Capacity Utilization	30.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2030 Wellsville Alternative Action - (Improved)
16: Four Corners Road & US 56 | PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	130	60	0	120	20	50	140	5	70	170	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	137	63	0	126	21	53	147	5	74	179	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	666	582	150	713	584	179	179			153		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	666	582	150	713	584	179	179			153		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	65	93	100	67	98	96			95		
cM capacity (veh/h)	257	388	896	221	386	869	1397			1434		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	205	147	205	253
Volume Left	5	0	53	74
Volume Right	63	21	5	0
cSH	462	420	1397	1434
Volume to Capacity	0.44	0.35	0.04	0.05
Queue Length 95th (ft)	56	39	3	4
Control Delay (s)	18.8	18.1	2.2	2.5
Lane LOS	C	C	A	A
Approach Delay (s)	18.8	18.1	2.2	2.5
Approach LOS	C	C		

Intersection Summary			
Average Delay	9.4		
Intersection Capacity Utilization	39.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2030 Wellsville Alternative Action - (Improved)
17: 191st Street & US 56 | PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	50	10	0	10	10	0	0	130	5	0	170	20
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	53	11	0	11	11	0	0	137	5	0	179	21
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	334	332	189	334	339	139	200			142		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	334	332	189	334	339	139	200			142		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	91	98	100	98	98	100	100			100		
cM capacity (veh/h)	611	591	858	615	585	914	1384			1453		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	63	21	142	200
Volume Left	53	11	0	0
Volume Right	0	0	5	21
cSH	607	600	1384	1453
Volume to Capacity	0.10	0.04	0.00	0.00
Queue Length 95th (ft)	9	3	0	0
Control Delay (s)	11.6	11.2	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	11.6	11.2	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	22.1%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Wellsville North Alternative - (Improved) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)
24: Sunflower Road & US 56 — PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	50	5	360	20	5	10	130	280	5	190	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.99			1.00			0.91			1.00	
Flt Protected		1.00			0.96			1.00			1.00	
Satd. Flow (prot)		1844			1763			1634			1758	
Flt Permitted		1.00			0.70			0.99			0.99	
Satd. Flow (perm)		1844			1287			1624			1745	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	53	5	379	21	5	11	137	295	5	200	5
RTOR Reduction (vph)	0	3	0	0	1	0	0	76	0	0	1	0
Lane Group Flow (vph)	0	55	0	0	404	0	0	367	0	0	209	0
Heavy Vehicles (%)	0%	2%	0%	3%	0%	0%	0%	12%	3%	0%	8%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		30.8			30.8			49.2			49.2	
Effective Green, g (s)		30.8			30.8			49.2			49.2	
Actuated g/C Ratio		0.34			0.34			0.55			0.55	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		631			440			888			954	
v/s Ratio Prot		0.03										
v/s Ratio Perm					c0.31			c0.23			0.12	
v/c Ratio		0.09			0.92			0.41			0.22	
Uniform Delay, d1		20.1			28.4			12.0			10.5	
Progression Factor		1.00			0.91			0.78			1.46	
Incremental Delay, d2		0.1			17.9			1.3			0.5	
Delay (s)		20.1			43.7			10.7			15.9	
Level of Service		C			D			B			B	
Approach Delay (s)		20.1			43.7			10.7			15.9	
Approach LOS		C			D			B			B	

Intersection Summary			
HCM Average Control Delay	24.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	65.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)
25: US 56 & 4th Street — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	330	130	90	470	150	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0			5.0	5.0	
Lane Util. Factor	1.00			1.00	1.00	
Frt	0.96			1.00	0.95	
Flt Protected	1.00			0.99	0.97	
Satd. Flow (prot)	1743			1803	1713	
Flt Permitted	1.00			0.86	0.97	
Satd. Flow (perm)	1743			1556	1713	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	347	137	95	495	158	84
RTOR Reduction (vph)	13	0	0	0	23	0
Lane Group Flow (vph)	471	0	0	590	219	0
Heavy Vehicles (%)	6%	2%	2%	5%	2%	3%
Turn Type			Perm			
Protected Phases	4			8	2	
Permitted Phases			8			
Actuated Green, G (s)	63.6			63.6	16.4	
Effective Green, g (s)	63.6			63.6	16.4	
Actuated g/C Ratio	0.71			0.71	0.18	
Clearance Time (s)	5.0			5.0	5.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	1232			1100	312	
v/s Ratio Prot	0.27				c0.13	
v/s Ratio Perm				c0.38		
v/c Ratio	0.38			0.54	0.70	
Uniform Delay, d1	5.3			6.2	34.5	
Progression Factor	1.00			0.37	1.00	
Incremental Delay, d2	0.9			1.5	7.0	
Delay (s)	6.2			3.7	41.5	
Level of Service	A			A	D	
Approach Delay (s)	6.2			3.7	41.5	
Approach LOS	A			A	D	

Intersection Summary			
HCM Average Control Delay	11.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	80.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)
28: I-35 SB Ramps & Sunflower Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	110	0	740	10	110	0	0	420	180
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)					5.0			5.0			5.0	
Lane Util. Factor					1.00			1.00			1.00	
Frt					0.88			1.00			0.96	
Flt Protected					0.99			1.00			1.00	
Satd. Flow (prot)					1346			1750			1428	
Flt Permitted					0.99			0.95			1.00	
Satd. Flow (perm)					1346			1667			1428	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	116	0	779	11	116	0	0	442	189
RTOR Reduction (vph)	0	0	0	0	227	0	0	0	0	0	24	0
Lane Group Flow (vph)	0	0	0	0	668	0	0	127	0	0	607	0
Heavy Vehicles (%)	0%	0%	0%	2%	0%	27%	20%	7%	0%	0%	37%	6%
Turn Type				custom			Perm					
Protected Phases				6	6			8			4	
Permitted Phases				6			8					
Actuated Green, G (s)					30.0			50.0			50.0	
Effective Green, g (s)					30.0			50.0			50.0	
Actuated g/C Ratio					0.33			0.56			0.56	
Clearance Time (s)					5.0			5.0			5.0	
Vehicle Extension (s)					3.0			3.0			3.0	
Lane Grp Cap (vph)					449			926			793	
v/s Ratio Prot					c0.50						c0.43	
v/s Ratio Perm								0.08				
v/c Ratio					1.49			0.14			0.77	
Uniform Delay, d1					30.0			9.6			15.5	
Progression Factor					1.00			1.20			1.00	
Incremental Delay, d2					230.8			0.3			7.0	
Delay (s)					260.8			11.9			22.4	
Level of Service					F			B			C	
Approach Delay (s)		0.0			260.8			11.9			22.4	
Approach LOS		A			F			B			C	

Intersection Summary			
HCM Average Control Delay	150.7	HCM Level of Service	F
HCM Volume to Capacity ratio	1.04		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	93.2%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)
29: I-35 NB Ramps & Sunflower Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	90	0	5	0	0	0	0	30	40	390	140	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0			5.0	
Lane Util. Factor		1.00						1.00			1.00	
Frt		0.99						0.92			1.00	
Flt Protected		0.95						1.00			0.96	
Satd. Flow (prot)		1660						1637			1418	
Flt Permitted		0.95						1.00			0.74	
Satd. Flow (perm)		1660						1637			1081	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	95	0	5	0	0	0	0	32	42	411	147	0
RTOR Reduction (vph)	0	3	0	0	0	0	0	10	0	0	0	0
Lane Group Flow (vph)	0	97	0	0	0	0	0	64	0	0	558	0
Heavy Vehicles (%)	9%	0%	0%	0%	0%	0%	0%	10%	5%	39%	2%	0%
Turn Type	Perm									Perm		
Protected Phases		2						8			4	
Permitted Phases	2									4		
Actuated Green, G (s)		10.6						69.4			69.4	
Effective Green, g (s)		10.6						69.4			69.4	
Actuated g/C Ratio		0.12						0.77			0.77	
Clearance Time (s)		5.0						5.0			5.0	
Vehicle Extension (s)		3.0						3.0			3.0	
Lane Grp Cap (vph)		196						1262			834	
v/s Ratio Prot								0.04				
v/s Ratio Perm		0.06									c0.52	
v/c Ratio		0.50						0.05			0.67	
Uniform Delay, d1		37.2						2.5			4.9	
Progression Factor		1.00						1.00			1.51	
Incremental Delay, d2		2.0						0.1			2.6	
Delay (s)		39.2						2.5			9.9	
Level of Service		D						A			A	
Approach Delay (s)		39.2			0.0			2.5			9.9	
Approach LOS		D			A			A			A	

Intersection Summary			
HCM Average Control Delay	13.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	49.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)

31: US 56 & Edgerton Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	200	30	70	390	50	40	50	30	90	100	10
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Hourly flow rate (vph)	11	217	33	76	424	54	42	53	33	98	105	11

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	261	554	127	214
Volume Left (vph)	11	76	42	98
Volume Right (vph)	33	54	33	11
Hadj (s)	0.07	0.04	0.10	0.13
Departure Headway (s)	6.2	5.7	7.0	6.8
Degree Utilization, x	0.45	0.87	0.25	0.40
Capacity (veh/h)	543	554	462	496
Control Delay (s)	14.2	35.2	12.3	14.2
Approach Delay (s)	14.2	35.2	12.3	14.2
Approach LOS	B	E	B	B

Intersection Summary			
Delay	24.1		
HCM Level of Service	C		
Intersection Capacity Utilization	66.5%	ICU Level of Service	C
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)

32: 207th & Sunflower Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	0	330	5	5	10	400	290	10	5	330	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	0	418	6	6	13	506	367	13	6	418	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1835	1826	421	2237	1823	373	424			380		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1835	1826	421	2237	1823	373	424			380		
tC, single (s)	7.1	6.5	6.7	7.1	6.5	6.2	4.6			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.7	3.5	4.0	3.3	2.6			2.2		
p0 queue free %	78	100	23	0	82	98	45			99		
cM capacity (veh/h)	29	35	545	4	35	677	924			1190		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	424	25	886	430
Volume Left	6	6	506	6
Volume Right	418	13	13	6
cSH	430	14	924	1190
Volume to Capacity	0.99	1.77	0.55	0.01
Queue Length 95th (ft)	307	96	85	0
Control Delay (s)	71.6	908.5	11.8	0.2
Lane LOS	F	F	B	A
Approach Delay (s)	71.6	908.5	11.8	0.2
Approach LOS	F	F		

Intersection Summary			
Average Delay	36.2		
Intersection Capacity Utilization	86.9%	ICU Level of Service	E
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)

33: 207th & COOP Rd — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	300	340	60	30	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	14	405	459	81	41	14
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	541				932	500
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	541				932	500
tC, single (s)	4.1				6.5	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.6	3.3
p0 queue free %	99				86	98
cM capacity (veh/h)	1038				286	575

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	419	541	54
Volume Left	14	0	41
Volume Right	0	81	14
cSH	1038	1700	327
Volume to Capacity	0.01	0.32	0.17
Queue Length 95th (ft)	1	0	15
Control Delay (s)	0.4	0.0	18.2
Lane LOS	A		C
Approach Delay (s)	0.4	0.0	18.2
Approach LOS			C

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	33.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)

34: 207th & Edgerton Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	170	0	10	210	130	5	10	5	140	5	20
Peak Hour Factor	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Hourly flow rate (vph)	30	258	0	15	318	197	8	15	8	212	8	30

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	288	530	30	250
Volume Left (vph)	30	15	8	212
Volume Right (vph)	0	197	8	30
Hadj (s)	1.46	0.73	-0.10	0.26
Departure Headway (s)	7.4	6.3	7.4	6.9
Degree Utilization, x	0.59	0.93	0.06	0.48
Capacity (veh/h)	473	530	431	505
Control Delay (s)	20.7	47.4	10.8	16.0
Approach Delay (s)	20.7	47.4	10.8	16.0
Approach LOS	C	E	B	C

Intersection Summary			
Delay	32.3		
HCM Level of Service	D		
Intersection Capacity Utilization	43.6%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2030 Wellsville Alternative Action - (Improved)
35: 207th & Evening Star Rd | PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	20	5	220	20	5	180
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	40	10	440	40	10	360
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			50		965	45
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			50		965	45
tC, single (s)			5.0		6.4	7.1
tC, 2 stage (s)						
tF (s)			3.0		3.5	4.1
p0 queue free %			61		94	56
cM capacity (veh/h)			1125		174	824

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	50	480	370
Volume Left	0	440	10
Volume Right	10	0	360
cSH	1700	1125	748
Volume to Capacity	0.03	0.39	0.49
Queue Length 95th (ft)	0	47	69
Control Delay (s)	0.0	9.7	14.4
Lane LOS		A	B
Approach Delay (s)	0.0	9.7	14.4
Approach LOS			B

Intersection Summary			
Average Delay	11.1		
Intersection Capacity Utilization	38.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2030 Wellsville Alternative Action - (Improved)
36: 215th & Evening Star Rd | PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	5	5	170	220	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	10	10	340	440	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	350				190	180
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	350				190	180
tC, single (s)	4.1				7.3	6.2
tC, 2 stage (s)						
tF (s)	2.2				4.3	3.3
p0 queue free %	100				30	99
cM capacity (veh/h)	1220				629	868

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	10	350	450
Volume Left	0	0	440
Volume Right	0	340	10
cSH	1220	1700	633
Volume to Capacity	0.00	0.21	0.71
Queue Length 95th (ft)	0	0	147
Control Delay (s)	0.0	0.0	23.4
Lane LOS			C
Approach Delay (s)	0.0	0.0	23.4
Approach LOS			C

Intersection Summary			
Average Delay	13.0		
Intersection Capacity Utilization	29.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2030 Wellsville Alternative Action - (Improved)
37: 199th Street & West Waverley | PM Peak Hour

Movement	EBL	EBT	WBU	WBT	WBR	SWL	SWR
Lane Configurations							
Volume (veh/h)	0	720	0	780	10	90	0
Sign Control		Free		Free		Stop	
Grade		0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	783	0	848	11	98	0
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type		TWLTL		TWLTL			
Median storage veh)		2		2			
Upstream signal (ft)				802			
pX, platoon unblocked			0.00				
vC, conflicting volume	859		0			1636	853
vC1, stage 1 conf vol						853	
vC2, stage 2 conf vol						783	
vCu, unblocked vol	859		0			1636	853
tC, single (s)	4.1		0.0			6.4	6.2
tC, 2 stage (s)						5.4	
tF (s)	2.2		0.0			3.5	3.3
p0 queue free %	100		0			69	100
cM capacity (veh/h)	791		0			318	362

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SW 1
Volume Total	0	783	859	0	98
Volume Left	0	0	0	0	98
Volume Right	0	0	11	0	0
cSH	1700	1700	1700	1700	318
Volume to Capacity	0.00	0.46	0.51	0.00	0.31
Queue Length 95th (ft)	0	0	0	0	32
Control Delay (s)	0.0	0.0	0.0	0.0	21.3
Lane LOS					C
Approach Delay (s)	0.0		0.0		21.3
Approach LOS					C

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	53.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study | 2030 Wellsville Alternative Action - (Improved)
38: 199th Street & IH-35 SB Ramp | PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	600	210	140	190	0	0	0	0	10	0	600
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		1.00		1.00	1.00					1.00		1.00
Frt		0.97		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		1798		1736	1845					1805		1583
Flt Permitted		1.00		0.24	1.00					0.95		1.00
Satd. Flow (perm)		1798		437	1845					1805		1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	652	228	152	207	0	0	0	0	11	0	652
RTOR Reduction (vph)	0	9	0	0	0	0	0	0	0	0	0	616
Lane Group Flow (vph)	0	871	0	152	207	0	0	0	0	11	0	36
Heavy Vehicles (%)	0%	2%	2%	4%	3%	0%	0%	0%	0%	0%	0%	2%
Turn Type				pm+pt						Prot		custom
Protected Phases		4		3	8					6		
Permitted Phases				8								6
Actuated Green, G (s)		63.9		75.0	75.0					5.0		5.0
Effective Green, g (s)		63.9		75.0	75.0					5.0		5.0
Actuated g/C Ratio		0.71		0.83	0.83					0.06		0.06
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		1277		452	1538					100		88
v/s Ratio Prot		c0.48		c0.02	0.11					0.01		
v/s Ratio Perm				0.26								c0.02
v/c Ratio		0.68		0.34	0.13					0.11		0.41
Uniform Delay, d1		7.3		9.0	1.4					40.4		41.1
Progression Factor		0.81		1.57	1.10					1.00		1.00
Incremental Delay, d2		2.9		0.4	0.0					0.5		3.1
Delay (s)		8.9		14.6	1.6					40.9		44.2
Level of Service		A		B	A					D		D
Approach Delay (s)		8.9			7.1			0.0			44.1	
Approach LOS		A			A			A			D	

Intersection Summary			
HCM Average Control Delay	20.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	67.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)
39: 199th Street & IH-35 NB Ramp — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	500	120	0	0	280	20	50	0	60	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0		5.0			
Lane Util. Factor	1.00	1.00			1.00		1.00		1.00			
Frt	1.00	1.00			0.99		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1770	1845			1815		1770		1538			
Flt Permitted	0.48	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	902	1845			1815		1770		1538			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	543	130	0	0	304	22	54	0	65	0	0	0
RTOR Reduction (vph)	0	0	0	0	2	0	0	0	60	0	0	0
Lane Group Flow (vph)	543	130	0	0	324	0	54	0	5	0	0	0
Heavy Vehicles (%)	2%	3%	0%	0%	4%	0%	2%	0%	5%	0%	0%	0%
Turn Type	pm+pt						custom		custom			
Protected Phases	7	4			8							
Permitted Phases	4						2		2			
Actuated Green, G (s)	72.9	72.9			53.0		7.1		7.1			
Effective Green, g (s)	72.9	72.9			53.0		7.1		7.1			
Actuated g/C Ratio	0.81	0.81			0.59		0.08		0.08			
Clearance Time (s)	5.0	5.0			5.0		5.0		5.0			
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Lane Grp Cap (vph)	874	1494			1069		140		121			
v/s Ratio Prot	c0.10	0.07			0.18							
v/s Ratio Perm	c0.40						c0.03		0.00			
v/c Ratio	0.62	0.09			0.30		0.39		0.04			
Uniform Delay, d1	3.1	1.7			9.3		39.4		38.3			
Progression Factor	0.29	0.09			0.26		1.00		1.00			
Incremental Delay, d2	1.0	0.1			0.1		1.8		0.1			
Delay (s)	1.9	0.2			2.6		41.1		38.5			
Level of Service	A	A			A		D		D			
Approach Delay (s)		1.6			2.6			39.7			0.0	
Approach LOS		A			A			D			A	

Intersection Summary			
HCM Average Control Delay	5.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	67.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved)
40: 199th Street & East Waverley — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	160	10	5	300	10	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	174	11	5	326	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	820					
pX, platoon unblocked						
vC, conflicting volume			185		516	179
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			185		516	179
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	99
cM capacity (veh/h)			1402		520	869

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	185	332	16
Volume Left	0	5	11
Volume Right	11	0	5
cSH	1700	1402	601
Volume to Capacity	0.11	0.00	0.03
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.2	11.2
Lane LOS		A	B
Approach Delay (s)	0.0	0.2	11.2
Approach LOS			B

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	29.8%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Wellsville North Alternative - (Improved + Mitigated) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

1: 175th Street & Waverly Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	10	330	0	20	30	630	220	0	10	130	40
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00			1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85			0.91		1.00	1.00		1.00	0.96	
Flt Protected	0.95	1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1677			1819		1770	3539		1805	3407	
Flt Permitted	0.72	1.00			1.00		0.64	1.00		0.61	1.00	
Satd. Flow (perm)	1346	1677			1819		1190	3539		1154	3407	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	53	11	347	0	21	32	663	232	0	11	137	42
RTOR Reduction (vph)	0	309	0	0	29	0	0	0	0	0	20	0
Lane Group Flow (vph)	53	49	0	0	24	0	663	232	0	11	159	0
Heavy Vehicles (%)	2%	0%	2%	0%	0%	0%	2%	2%	0%	0%	2%	3%
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	9.8	9.8			9.8		70.2	61.9		51.1	47.8	
Effective Green, g (s)	9.8	9.8			9.8		70.2	61.9		51.1	47.8	
Actuated g/C Ratio	0.11	0.11			0.11		0.78	0.69		0.57	0.53	
Clearance Time (s)	5.0	5.0			5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	147	183			198		1040	2434		679	1809	
v/s Ratio Prot		0.03			0.01		c0.12	0.07		0.00	0.05	
v/s Ratio Perm	c0.04						c0.37			0.01		
v/c Ratio	0.36	0.27			0.12		0.64	0.10		0.02	0.09	
Uniform Delay, d1	37.2	36.8			36.2		4.9	4.7		8.5	10.4	
Progression Factor	1.00	1.00			1.00		0.58	0.76		1.00	1.00	
Incremental Delay, d2	1.5	0.8			0.3		1.1	0.1		0.0	0.1	
Delay (s)	38.7	37.6			36.5		4.0	3.6		8.5	10.5	
Level of Service	D	D			D		A	A		A	B	
Approach Delay (s)		37.7			36.5			3.9			10.4	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM Average Control Delay	14.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	72.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

2: US 56 & Gardner Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	130	440	60	300	900	440	50	890	220	320	930	120
Ideal Flow (vphpl)	1900	2000	1900	1900	2000	1900	1900	2000	1900	1900	1900	1900
Total Lost time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	0.97	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1736	3519	1583	1770	3689	1583	1770	3725	1568	3400	3475	
Flt Permitted	0.16	1.00	1.00	0.39	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	290	3519	1583	724	3689	1583	1770	3725	1568	3400	3475	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	463	63	316	947	463	53	937	232	337	979	126
RTOR Reduction (vph)	0	0	45	0	0	253	0	0	157	0	11	0
Lane Group Flow (vph)	137	463	18	316	947	210	53	937	75	337	1094	0
Heavy Vehicles (%)	4%	8%	2%	2%	3%	2%	2%	2%	3%	3%	2%	3%
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6			8			
Actuated Green, G (s)	31.8	25.2	25.2	33.8	26.2	26.2	3.9	29.2	29.2	11.3	36.6	
Effective Green, g (s)	31.8	25.2	25.2	33.8	26.2	26.2	3.9	29.2	29.2	11.3	36.6	
Actuated g/C Ratio	0.35	0.28	0.28	0.38	0.29	0.29	0.04	0.32	0.32	0.13	0.41	
Clearance Time (s)	2.5	5.9	5.9	2.5	5.9	5.9	2.5	5.8	5.8	2.5	5.8	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	209	985	443	360	1074	461	77	1209	509	427	1413	
v/s Ratio Prot	0.05	0.13		c0.07	c0.26		c0.03	c0.25		c0.10	0.31	
v/s Ratio Perm	0.18		0.01	0.26		0.13			0.05			
v/c Ratio	0.66	0.47	0.04	0.88	0.88	0.46	0.69	0.78	0.15	0.79	0.77	
Uniform Delay, d1	22.4	26.9	23.6	24.3	30.4	26.1	42.5	27.4	21.6	38.2	23.1	
Progression Factor	1.31	0.66	0.49	1.32	1.15	1.95	0.73	0.56	0.30	1.00	1.00	
Incremental Delay, d2	7.1	1.6	0.2	15.7	7.7	2.3	14.0	1.9	0.1	9.4	2.7	
Delay (s)	36.6	19.2	11.7	47.8	42.7	53.0	45.1	17.3	6.6	47.6	25.8	
Level of Service	D	B	B	D	D	D	D	B	A	D	C	
Approach Delay (s)		22.1			46.4			16.5			30.9	
Approach LOS		C			D			B			C	

Intersection Summary			
HCM Average Control Delay	31.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.8
Intersection Capacity Utilization	80.1%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

8: US-56 & I-35 SB Ramps

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	2720	280	660	1250	0	0	0	0	170	0	1560
Ideal Flow (vphpl)	1900	1900	1900	1900	2000	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		0.95		1.00	0.95					1.00		0.88
Frt		0.99		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		3486		1736	3725					1770		2787
Flt Permitted		1.00		0.22	1.00					0.95		1.00
Satd. Flow (perm)		3486		395	3725					1770		2787
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	2863	295	695	1316	0	0	0	0	179	0	1642
RTOR Reduction (vph)	0	6	0	0	0	0	0	0	0	0	0	7
Lane Group Flow (vph)	0	3152	0	695	1316	0	0	0	0	179	0	1635
Heavy Vehicles (%)	0%	2%	3%	4%	2%	0%	0%	0%	0%	2%	0%	2%
Turn Type				pm+pt						custom		custom
Protected Phases		2		1	6					4		5
Permitted Phases				6						4		4
Actuated Green, G (s)		69.0		44.5	44.5					10.0		60.5
Effective Green, g (s)		69.0		44.5	44.5					10.0		60.5
Actuated g/C Ratio		0.57		0.37	0.37					0.08		0.50
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		2004		437	1381					148		1521
v/s Ratio Prot		c0.90		c0.34	0.35					0.10		c0.45
v/s Ratio Perm				c0.25								0.13
v/c Ratio		1.57		1.59	0.95					1.21		1.07
Uniform Delay, d1		25.5		34.4	36.7					55.0		29.8
Progression Factor		0.75		0.92	0.89					1.00		1.00
Incremental Delay, d2		257.9		273.0	10.9					141.2		46.0
Delay (s)		277.1		304.6	43.7					196.2		75.8
Level of Service		F		F	D					F		E
Approach Delay (s)		277.1			133.8			0.0			87.6	
Approach LOS		F			F			A			F	

Intersection Summary			
HCM Average Control Delay	186.5	HCM Level of Service	F
HCM Volume to Capacity ratio	1.43		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	5.0
Intersection Capacity Utilization	141.8%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

9: US-56 & I-35 NB Ramps

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1530	0	0	1810	580	100	0	400	0	0	0
Ideal Flow (vphpl)	1900	2000	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95	0.95			
Frt		1.00			1.00	0.85	1.00	0.85	0.85			
Flt Protected		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (prot)		3725			3539	1538	1671	1408	1408			
Flt Permitted		1.00			1.00	1.00	0.95	1.00	1.00			
Satd. Flow (perm)		3725			3539	1538	1671	1408	1408			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	1611	0	0	1905	611	105	0	421	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	83	0	0	0	0	0	0
Lane Group Flow (vph)	0	1611	0	0	1905	528	105	211	210	0	0	0
Heavy Vehicles (%)	0%	2%	0%	0%	2%	5%	8%	0%	9%	0%	0%	0%
Turn Type						Perm	Perm		Perm			
Protected Phases		2			6			8				
Permitted Phases						6	8		8			
Actuated Green, G (s)		86.2			86.2	86.2	23.8	23.8	23.8			
Effective Green, g (s)		86.2			86.2	86.2	23.8	23.8	23.8			
Actuated g/C Ratio		0.72			0.72	0.72	0.20	0.20	0.20			
Clearance Time (s)		5.0			5.0	5.0	5.0	5.0	5.0			
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0	3.0			
Lane Grp Cap (vph)		2676			2542	1105	331	279	279			
v/s Ratio Prot		0.43			c0.54			c0.15				
v/s Ratio Perm						0.34	0.06		0.15			
v/c Ratio		0.60			0.75	0.48	0.32	0.76	0.75			
Uniform Delay, d1		8.4			10.3	7.2	41.1	45.4	45.3			
Progression Factor		0.39			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2		0.1			1.2	0.3	0.6	11.1	10.9			
Delay (s)		3.4			11.6	7.6	41.7	56.5	56.2			
Level of Service		A			B	A	D	E	E			
Approach Delay (s)		3.4			10.6			53.4			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM Average Control Delay	12.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	86.9%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

2030 Wellsville North Alternative - (Improved + Mitigated) - PM Peak Hour - Synchro Intersection LOS

11: Waverly Road & US 56

PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	150	20	310	110	40	60	130	0	30	200	630
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor		0.95	1.00	0.97	0.95		1.00	0.95		1.00	0.95	1.00
Frt		1.00	0.85	1.00	0.96		1.00	1.00		1.00	1.00	0.85
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)		3539	1615	3400	3372		1770	3167		1752	3343	1583
Flt Permitted		1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)		3539	1615	3400	3372		1770	3167		1752	3343	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	158	21	326	116	42	63	137	0	32	211	663
RTOR Reduction (vph)	0	0	19	0	29	0	0	0	0	0	0	374
Lane Group Flow (vph)	0	158	2	326	129	0	63	137	0	32	211	289
Heavy Vehicles (%)	0%	2%	0%	3%	2%	5%	2%	14%	0%	3%	8%	2%
Turn Type	Prot		Perm	Prot			Prot		Perm	Prot		Perm
Protected Phases	3	8		7	4		5	2		1	6	
Permitted Phases			8					2	2			6
Actuated Green, G (s)		9.4	9.4	13.9	28.3		7.5	41.8		4.9	39.2	39.2
Effective Green, g (s)		9.4	9.4	13.9	28.3		7.5	41.8		4.9	39.2	39.2
Actuated g/C Ratio		0.10	0.10	0.15	0.31		0.08	0.46		0.05	0.44	0.44
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)		370	169	525	1060		148	1471		95	1456	689
v/s Ratio Prot		c0.04		c0.10	0.04		c0.04	c0.04		0.02	0.06	
v/s Ratio Perm			0.00									c0.18
v/c Ratio		0.43	0.01	0.62	0.12		0.43	0.09		0.34	0.14	0.42
Uniform Delay, d1		37.8	36.1	35.6	22.0		39.2	13.5		41.0	15.3	17.5
Progression Factor		1.01	1.01	0.91	0.81		1.00	1.00		1.46	0.30	2.88
Incremental Delay, d2		0.8	0.0	2.2	0.1		2.0	0.1		1.1	0.1	1.0
Delay (s)		38.9	36.4	34.5	17.9		41.2	13.6		60.9	4.6	51.5
Level of Service		D	D	C	B		D	B		E	A	D
Approach Delay (s)		38.6			29.1			22.3			40.9	
Approach LOS		D			C			C			D	

Intersection Summary			
HCM Average Control Delay	35.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	25.0
Intersection Capacity Utilization	59.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

13: 183rd Street & US 56

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	40	20	5	20	50	5	0	170	30	5	210	20
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	42	21	5	21	53	5	0	179	32	5	221	21
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	468	453	232	453	447	195	242			211		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	468	453	232	453	447	195	242			211		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	91	96	99	96	90	99	100			100		
cM capacity (veh/h)	459	504	813	499	504	852	1336			1372		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	68	79	211	247
Volume Left	42	21	0	5
Volume Right	5	5	32	21
cSH	489	517	1336	1372
Volume to Capacity	0.14	0.15	0.00	0.00
Queue Length 95th (ft)	12	13	0	0
Control Delay (s)	13.6	13.2	0.0	0.2
Lane LOS	B	B		A
Approach Delay (s)	13.6	13.2	0.0	0.2
Approach LOS	B	B		

Intersection Summary			
Average Delay	3.3		
Intersection Capacity Utilization	30.4%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

16: Four Corners Road & US 56

PM Peak Hour

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	5	130	60	0	120	20	50	140	5	70	170	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	5	137	63	0	126	21	53	147	5	74	179	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	666	582	150	713	584	179	179			153		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	666	582	150	713	584	179	179			153		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	65	93	100	67	98	96			95		
cM capacity (veh/h)	257	388	896	221	386	869	1397			1434		

Direction, Lane #	NB 1	SB 1	NE 1	SW 1
Volume Total	205	147	205	253
Volume Left	5	0	53	74
Volume Right	63	21	5	0
cSH	462	420	1397	1434
Volume to Capacity	0.44	0.35	0.04	0.05
Queue Length 95th (ft)	56	39	3	4
Control Delay (s)	18.8	18.1	2.2	2.5
Lane LOS	C	C	A	A
Approach Delay (s)	18.8	18.1	2.2	2.5
Approach LOS	C	C		

Intersection Summary			
Average Delay	9.4		
Intersection Capacity Utilization	39.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

17: 191st Street & US 56

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (veh/h)	50	10	0	10	10	0	0	130	5	0	170	20
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	53	11	0	11	11	0	0	137	5	0	179	21
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	334	332	189	334	339	139	200			142		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	334	332	189	334	339	139	200			142		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	91	98	100	98	98	100	100			100		
cM capacity (veh/h)	611	591	858	615	585	914	1384			1453		

Direction, Lane #	EB 1	WB 1	NE 1	SW 1
Volume Total	63	21	142	200
Volume Left	53	11	0	0
Volume Right	0	0	5	21
cSH	607	600	1384	1453
Volume to Capacity	0.10	0.04	0.00	0.00
Queue Length 95th (ft)	9	3	0	0
Control Delay (s)	11.6	11.2	0.0	0.0
Lane LOS	B	B		
Approach Delay (s)	11.6	11.2	0.0	0.0
Approach LOS	B	B		

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	22.1%	ICU Level of Service	A
Analysis Period (min)	15		

2030 Wellsville North Alternative - (Improved + Mitigated) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

24: Sunflower Road & US 56

PM Peak Hour

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	50	5	360	20	5	10	130	280	5	190	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.99			1.00			0.91			1.00	
Flt Protected		1.00			0.96			1.00			1.00	
Satd. Flow (prot)		1844			1763			1634			1758	
Flt Permitted		1.00			0.70			0.99			0.99	
Satd. Flow (perm)		1844			1287			1624			1745	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	53	5	379	21	5	11	137	295	5	200	5
RTOR Reduction (vph)	0	3	0	0	1	0	0	70	0	0	1	0
Lane Group Flow (vph)	0	55	0	0	404	0	0	373	0	0	209	0
Heavy Vehicles (%)	0%	2%	0%	3%	0%	0%	0%	12%	3%	0%	8%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		32.4			32.4			42.6			42.6	
Effective Green, g (s)		32.4			32.4			42.6			42.6	
Actuated g/C Ratio		0.38			0.38			0.50			0.50	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		703			491			814			875	
v/s Ratio Prot		0.03										
v/s Ratio Perm					c0.31			c0.23			0.12	
v/c Ratio		0.08			0.82			0.46			0.24	
Uniform Delay, d1		16.8			23.7			13.7			12.0	
Progression Factor		1.00			1.00			1.17			1.00	
Incremental Delay, d2		0.0			10.7			1.7			0.6	
Delay (s)		16.8			34.5			17.8			12.7	
Level of Service		B			C			B			B	
Approach Delay (s)		16.8			34.5			17.8			12.7	
Approach LOS		B			C			B			B	

Intersection Summary			
HCM Average Control Delay	22.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	65.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

25: US 56 & 4th Street

PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	330	130	90	470	150	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0			5.0	5.0	
Lane Util. Factor	1.00			1.00	1.00	
Frt	0.96			1.00	0.95	
Flt Protected	1.00			0.99	0.97	
Satd. Flow (prot)	1743			1803	1713	
Flt Permitted	1.00			0.86	0.97	
Satd. Flow (perm)	1743			1558	1713	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	347	137	95	495	158	84
RTOR Reduction (vph)	14	0	0	0	24	0
Lane Group Flow (vph)	470	0	0	590	218	0
Heavy Vehicles (%)	6%	2%	2%	5%	2%	3%
Turn Type			Perm			
Protected Phases	4			8	2	
Permitted Phases			8			
Actuated Green, G (s)	59.6			59.6	15.4	
Effective Green, g (s)	59.6			59.6	15.4	
Actuated g/C Ratio	0.70			0.70	0.18	
Clearance Time (s)	5.0			5.0	5.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	1222			1092	310	
v/s Ratio Prot	0.27				c0.13	
v/s Ratio Perm				c0.38		
v/c Ratio	0.38			0.54	0.70	
Uniform Delay, d1	5.2			6.1	32.7	
Progression Factor	0.64			1.78	1.00	
Incremental Delay, d2	0.9			1.7	7.1	
Delay (s)	4.2			12.5	39.7	
Level of Service	A			B	D	
Approach Delay (s)	4.2			12.5	39.7	
Approach LOS	A			B	D	

Intersection Summary			
HCM Average Control Delay	14.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	80.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

28: I-35 SB Ramps & Sunflower Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	110	0	740	10	110	0	0	420	180
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0	5.0			5.0			5.0	
Lane Util. Factor				1.00	1.00			1.00			1.00	
Frt				1.00	0.85			1.00			0.96	
Flt Protected				0.95	1.00			1.00			1.00	
Satd. Flow (prot)				1770	1272			1750			1428	
Flt Permitted				0.95	1.00			0.95			1.00	
Satd. Flow (perm)				1770	1272			1672			1428	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	116	0	779	11	116	0	0	442	189
RTOR Reduction (vph)	0	0	0	0	629	0	0	0	0	0	10	0
Lane Group Flow (vph)	0	0	0	116	150	0	0	127	0	0	621	0
Heavy Vehicles (%)	0%	0%	0%	2%	0%	27%	20%	7%	0%	0%	37%	6%
Turn Type				custom			Perm					
Protected Phases				6	6			8			4	
Permitted Phases				6			8					
Actuated Green, G (s)				17.3	17.3			62.7			62.7	
Effective Green, g (s)				17.3	17.3			62.7			62.7	
Actuated g/C Ratio				0.19	0.19			0.70			0.70	
Clearance Time (s)				5.0	5.0			5.0			5.0	
Vehicle Extension (s)				3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)				340	245			1165			995	
v/s Ratio Prot				0.07	c0.12						c0.44	
v/s Ratio Perm								0.08				
v/c Ratio				0.34	0.61			0.11			0.62	
Uniform Delay, d1				31.4	33.3			4.5			7.3	
Progression Factor				1.00	1.00			1.85			1.00	
Incremental Delay, d2				0.6	4.5			0.2			3.0	
Delay (s)				32.0	37.7			8.5			10.3	
Level of Service				C	D			A			B	
Approach Delay (s)		0.0			37.0			8.5			10.3	
Approach LOS		A			D			A			B	

Intersection Summary			
HCM Average Control Delay	24.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	87.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

29: I-35 NB Ramps & Sunflower Road

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	90	0	5	0	0	0	0	30	40	390	140	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						5.0	5.0		5.0	
Lane Util. Factor		1.00						1.00	1.00		1.00	
Frt		0.99						1.00	0.85		1.00	
Flt Protected		0.95						1.00	1.00		0.96	
Satd. Flow (prot)		1660						1727	1538		1418	
Flt Permitted		0.95						1.00	1.00		0.76	
Satd. Flow (perm)		1660						1727	1538		1121	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	95	0	5	0	0	0	0	32	42	411	147	0
RTOR Reduction (vph)	0	3	0	0	0	0	0	0	10	0	0	0
Lane Group Flow (vph)	0	97	0	0	0	0	0	32	32	0	558	0
Heavy Vehicles (%)	9%	0%	0%	0%	0%	0%	0%	10%	5%	39%	2%	0%
Turn Type	Perm								Perm	Perm		
Protected Phases		2						8			4	
Permitted Phases	2								8	4		
Actuated Green, G (s)		10.6						69.4	69.4		69.4	
Effective Green, g (s)		10.6						69.4	69.4		69.4	
Actuated g/C Ratio		0.12						0.77	0.77		0.77	
Clearance Time (s)		5.0						5.0	5.0		5.0	
Vehicle Extension (s)		3.0						3.0	3.0		3.0	
Lane Grp Cap (vph)		196						1332	1186		864	
v/s Ratio Prot								0.02				
v/s Ratio Perm		0.06							0.02		c0.50	
v/c Ratio		0.50						0.02	0.03		0.65	
Uniform Delay, d1		37.2						2.4	2.4		4.7	
Progression Factor		1.00						1.00	1.00		0.73	
Incremental Delay, d2		2.0						0.0	0.0		3.2	
Delay (s)		39.2						2.4	2.5		6.6	
Level of Service		D						A	A		A	
Approach Delay (s)		39.2			0.0			2.4			6.6	
Approach LOS		D			A			A			A	

Intersection Summary			
HCM Average Control Delay	10.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	50.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

2030 Wellsville North Alternative - (Improved + Mitigated) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)
31: US 56 & Edgerton Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	200	30	70	390	50	40	50	30	90	100	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0			5.0			5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Frt	1.00	0.98		1.00	0.98			0.97			0.99	
Flt Protected	0.95	1.00		0.95	1.00			0.98			0.98	
Satd. Flow (prot)	1805	1719		1597	1815			1627			1777	
Flt Permitted	0.45	1.00		0.60	1.00			0.83			0.79	
Satd. Flow (perm)	852	1719		1016	1815			1368			1427	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.95	0.95	0.92	0.92	0.95	0.95
Adj. Flow (vph)	11	217	33	76	424	54	42	53	33	98	105	11
RTOR Reduction (vph)	0	5	0	0	4	0	0	17	0	0	2	0
Lane Group Flow (vph)	11	245	0	76	474	0	0	111	0	0	212	0
Heavy Vehicles (%)	0%	7%	17%	13%	3%	2%	10%	6%	20%	4%	4%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	57.6	57.6		57.6	57.6			17.4			17.4	
Effective Green, g (s)	57.6	57.6		57.6	57.6			17.4			17.4	
Actuated g/C Ratio	0.68	0.68		0.68	0.68			0.20			0.20	
Clearance Time (s)	5.0	5.0		5.0	5.0			5.0			5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	577	1165		688	1230			280			292	
v/s Ratio Prot		0.14			c0.26							
v/s Ratio Perm	0.01			0.07				0.08			c0.15	
v/c Ratio	0.02	0.21		0.11	0.39			0.39			0.72	
Uniform Delay, d1	4.5	5.2		4.8	6.0			29.2			31.6	
Progression Factor	1.00	1.00		1.03	1.36			1.00			1.00	
Incremental Delay, d2	0.1	0.4		0.3	0.8			0.9			8.6	
Delay (s)	4.5	5.6		5.2	8.9			30.2			40.2	
Level of Service	A	A		A	A			C			D	
Approach Delay (s)		5.5			8.4			30.2			40.2	
Approach LOS		A			A			C			D	

Intersection Summary			
HCM Average Control Delay	16.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.46		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	55.6%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)
32: 207th & Sunflower Road — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	0	330	5	5	10	400	290	10	5	330	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	6	0	418	6	6	13	506	367	13	6	418	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1835	1826	421	2237	1823	373	424			380		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1835	1826	421	2237	1823	373	424			380		
tC, single (s)	7.1	6.5	6.7	7.1	6.5	6.2	4.6			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.7	3.5	4.0	3.3	2.6			2.2		
p0 queue free %	78	100	23	0	82	98	45			99		
cM capacity (veh/h)	29	35	545	4	35	677	924			1190		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	424	25	886	430
Volume Left	6	6	506	6
Volume Right	418	13	13	6
cSH	430	14	924	1190
Volume to Capacity	0.99	1.77	0.55	0.01
Queue Length 95th (ft)	307	96	85	0
Control Delay (s)	71.6	908.5	11.8	0.2
Lane LOS	F	F	B	A
Approach Delay (s)	71.6	908.5	11.8	0.2
Approach LOS	F	F		

Intersection Summary			
Average Delay	36.2		
Intersection Capacity Utilization	86.9%	ICU Level of Service	E
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)
33: 207th & COOP Rd — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	300	340	60	30	10
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.74	0.74	0.74	0.74	0.74	0.74
Hourly flow rate (vph)	14	405	459	81	41	14
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	541				932	500
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	541				932	500
tC, single (s)	4.1				6.5	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.6	3.3
p0 queue free %	99				86	98
cM capacity (veh/h)	1038				286	575

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	419	541	54
Volume Left	14	0	41
Volume Right	0	81	14
cSH	1038	1700	327
Volume to Capacity	0.01	0.32	0.17
Queue Length 95th (ft)	1	0	15
Control Delay (s)	0.4	0.0	18.2
Lane LOS	A		C
Approach Delay (s)	0.4	0.0	18.2
Approach LOS			C

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	33.9%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)
34: 207th & Edgerton Rd — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	170	0	10	210	130	5	10	5	140	5	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		1.00			0.95			0.97			0.98	
Flt Protected		0.99			1.00			0.99			0.96	
Satd. Flow (prot)		1022			1156			1810			1638	
Flt Permitted		0.93			0.99			0.91			0.74	
Satd. Flow (perm)		953			1144			1665			1258	
Peak-hour factor, PHF	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Adj. Flow (vph)	30	258	0	15	318	197	8	15	8	212	8	30
RTOR Reduction (vph)	0	0	0	0	36	0	0	6	0	0	7	0
Lane Group Flow (vph)	0	288	0	0	494	0	0	25	0	0	243	0
Heavy Vehicles (%)	50%	89%	0%	0%	92%	2%	0%	0%	0%	2%	0%	65%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		26.7			26.7			14.4			14.4	
Effective Green, g (s)		26.7			26.7			14.4			14.4	
Actuated g/C Ratio		0.52			0.52			0.28			0.28	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		498			598			469			355	
v/s Ratio Prot												
v/s Ratio Perm		0.30			c0.43			0.02			c0.19	
v/c Ratio		0.58			0.83			0.05			0.68	
Uniform Delay, d1		8.3			10.2			13.4			16.3	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		1.6			9.1			0.0			5.4	
Delay (s)		10.0			19.3			13.4			21.7	
Level of Service		A			B			B			C	
Approach Delay (s)		10.0			19.3			13.4			21.7	
Approach LOS		A			B			B			C	

Intersection Summary			
HCM Average Control Delay	17.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	51.1	Sum of lost time (s)	10.0
Intersection Capacity Utilization	45.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

2030 Wellsville North Alternative - (Improved + Mitigated) - PM Peak Hour - Synchro Intersection LOS

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)
35: 207th & Evening Star Rd — PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	20	5	220	20	5	180
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	40	10	440	40	10	360
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			50		965	45
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			50		965	45
tC, single (s)			5.0		6.4	7.1
tC, 2 stage (s)						
tF (s)			3.0		3.5	4.1
p0 queue free %			61		94	56
cM capacity (veh/h)			1125		174	824

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	50	480	370
Volume Left	0	440	10
Volume Right	10	0	360
cSH	1700	1125	748
Volume to Capacity	0.03	0.39	0.49
Queue Length 95th (ft)	0	47	69
Control Delay (s)	0.0	9.7	14.4
Lane LOS		A	B
Approach Delay (s)	0.0	9.7	14.4
Approach LOS			B

Intersection Summary			
Average Delay	11.1		
Intersection Capacity Utilization	38.0%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)
36: 215th & Evening Star Rd — PM Peak Hour

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	0	5	5	170	220	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.50	0.50	0.50	0.50	0.50	0.50
Hourly flow rate (vph)	0	10	10	340	440	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	350				20	10
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	350				20	10
tC, single (s)	4.1				7.3	6.2
tC, 2 stage (s)						
tF (s)	2.2				4.3	3.3
p0 queue free %	100				45	99
cM capacity (veh/h)	1220				805	1077

Direction, Lane #	EB 1	WB 1	WB 2	SB 1
Volume Total	10	10	340	450
Volume Left	0	0	0	440
Volume Right	0	0	340	10
cSH	1220	1700	1700	809
Volume to Capacity	0.00	0.01	0.20	0.56
Queue Length 95th (ft)	0	0	0	87
Control Delay (s)	0.0	0.0	0.0	14.9
Lane LOS				B
Approach Delay (s)	0.0	0.0		14.9
Approach LOS				B

Intersection Summary			
Average Delay	8.3		
Intersection Capacity Utilization	22.5%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)
37: 199th Street & West Waverley — PM Peak Hour

Movement	EBL	EBT	WBU	WBT	WBR	SWL	SWR
Lane Configurations							
Volume (veh/h)	0	720	0	780	10	90	0
Sign Control		Free		Free		Stop	
Grade		0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	783	0	848	11	98	0
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type		TWLTL		TWLTL			
Median storage veh)		2		2			
Upstream signal (ft)				802			
pX, platoon unblocked			0.00				
vC, conflicting volume	859		0			1636	853
vC1, stage 1 conf vol						853	
vC2, stage 2 conf vol						783	
vCu, unblocked vol	859		0			1636	853
tC, single (s)	4.1		0.0			6.4	6.2
tC, 2 stage (s)						5.4	
tF (s)	2.2		0.0			3.5	3.3
p0 queue free %	100		0			69	100
cM capacity (veh/h)	791		0			318	362

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SW 1
Volume Total	0	783	859	0	98
Volume Left	0	0	0	0	98
Volume Right	0	0	11	0	0
cSH	1700	1700	1700	1700	318
Volume to Capacity	0.00	0.46	0.51	0.00	0.31
Queue Length 95th (ft)	0	0	0	0	32
Control Delay (s)	0.0	0.0	0.0	0.0	21.3
Lane LOS					C
Approach Delay (s)	0.0		0.0		21.3
Approach LOS					C

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	53.3%	ICU Level of Service	A
Analysis Period (min)	15		

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)
38: 199th Street & IH-35 SB Ramp — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	600	210	140	190	0	0	0	0	10	0	600
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0					5.0		5.0
Lane Util. Factor		1.00		1.00	1.00					1.00		1.00
Frt		0.97		1.00	1.00					1.00		0.85
Flt Protected		1.00		0.95	1.00					0.95		1.00
Satd. Flow (prot)		1798		1736	1845					1805		1583
Flt Permitted		1.00		0.24	1.00					0.95		1.00
Satd. Flow (perm)		1798		437	1845					1805		1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	652	228	152	207	0	0	0	0	11	0	652
RTOR Reduction (vph)	0	9	0	0	0	0	0	0	0	0	0	616
Lane Group Flow (vph)	0	871	0	152	207	0	0	0	0	11	0	36
Heavy Vehicles (%)	0%	2%	2%	4%	3%	0%	0%	0%	0%	0%	0%	2%
Turn Type				pm+pt						Prot		custom
Protected Phases		4		3	8					6		
Permitted Phases				8								6
Actuated Green, G (s)		63.9		75.0	75.0					5.0		5.0
Effective Green, g (s)		63.9		75.0	75.0					5.0		5.0
Actuated g/C Ratio		0.71		0.83	0.83					0.06		0.06
Clearance Time (s)		5.0		5.0	5.0					5.0		5.0
Vehicle Extension (s)		3.0		3.0	3.0					3.0		3.0
Lane Grp Cap (vph)		1277		452	1538					100		88
v/s Ratio Prot		c0.48		c0.02	0.11					0.01		
v/s Ratio Perm				0.26								c0.02
v/c Ratio		0.68		0.34	0.13					0.11		0.41
Uniform Delay, d1		7.3		9.0	1.4					40.4		41.1
Progression Factor		1.00		1.57	1.10					1.00		1.00
Incremental Delay, d2		3.0		0.4	0.0					0.5		3.1
Delay (s)		10.3		14.6	1.6					40.9		44.2
Level of Service		B		B	A					D		D
Approach Delay (s)		10.3			7.1			0.0			44.1	
Approach LOS		B			A			A			D	

Intersection Summary			
HCM Average Control Delay	21.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	67.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

39: 199th Street & IH-35 NB Ramp

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	500	120	0	0	280	20	50	0	60	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0		5.0			
Lane Util. Factor	1.00	1.00			1.00		1.00		1.00			
Frt	1.00	1.00			0.99		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1770	1845			1815		1770		1538			
Flt Permitted	0.48	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	902	1845			1815		1770		1538			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	543	130	0	0	304	22	54	0	65	0	0	0
RTOR Reduction (vph)	0	0	0	0	2	0	0	0	60	0	0	0
Lane Group Flow (vph)	543	130	0	0	324	0	54	0	5	0	0	0
Heavy Vehicles (%)	2%	3%	0%	0%	4%	0%	2%	0%	5%	0%	0%	0%
Turn Type	pm+pt						custom		custom			
Protected Phases	7	4			8							
Permitted Phases	4						2		2			
Actuated Green, G (s)	72.9	72.9			53.0		7.1		7.1			
Effective Green, g (s)	72.9	72.9			53.0		7.1		7.1			
Actuated g/C Ratio	0.81	0.81			0.59		0.08		0.08			
Clearance Time (s)	5.0	5.0			5.0		5.0		5.0			
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Lane Grp Cap (vph)	874	1494			1069		140		121			
v/s Ratio Prot	c0.10	0.07			0.18							
v/s Ratio Perm	c0.40						c0.03		0.00			
v/c Ratio	0.62	0.09			0.30		0.39		0.04			
Uniform Delay, d1	3.1	1.7			9.3		39.4		38.3			
Progression Factor	0.35	0.09			0.26		1.00		1.00			
Incremental Delay, d2	1.0	0.1			0.1		1.8		0.1			
Delay (s)	2.1	0.2			2.6		41.1		38.5			
Level of Service	A	A			A		D		D			
Approach Delay (s)		1.8			2.6			39.7			0.0	
Approach LOS		A			A			D			A	

Intersection Summary			
HCM Average Control Delay	6.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	67.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

BNSF NEPA Traffic Study — 2030 Wellsville Alternative Action - (Improved+Mitigated)

40: 199th Street & East Waverley

PM Peak Hour

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	160	10	5	300	10	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	174	11	5	326	11	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	820					
pX, platoon unblocked						
vC, conflicting volume			185		516	179
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			185		516	179
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	99
cM capacity (veh/h)			1402		520	869

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	185	332	16
Volume Left	0	5	11
Volume Right	11	0	5
cSH	1700	1402	601
Volume to Capacity	0.11	0.00	0.03
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.2	11.2
Lane LOS		A	B
Approach Delay (s)	0.0	0.2	11.2
Approach LOS			B

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	29.8%	ICU Level of Service	A
Analysis Period (min)	15		

2010 Wellsville North No Action - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

________________________Operational Analysis________________________________

```
Analyst:                Tom Hiles
Agency or Company:      HDR Inc.
Date Performed:         3/27/2008 10:25:01 AM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Northbound
From/To:                Edgerton Road to Sunflower Road
Jurisdiction:
Analysis Year:          2010
Description:  NEPA Traffic Study
```

________________________Flow Inputs and Adjustments_________________________

```
Volume, V                                 1185          veh/h
Peak-hour factor, PHF                     0.90
Peak 15-min volume, v15                   329           v
Trucks and buses                          9             %
Recreational vehicles                     0             %
Terrain type:                             Level
    Grade                                 0.00          %
    Segment length                        0.00          mi
Trucks and buses PCE, ET                  1.5
Recreational vehicle PCE, ER              1.2
Heavy vehicle adjustment, fHV             0.957
Driver population factor, fp              1.00
Flow rate, vp                             688           pc/h/ln
```

________________________Speed Inputs and Adjustments________________________

```
Lane width                                12.0          ft
Right-shoulder lateral clearance          6.0           ft
Interchange density                       0.50          interchange/mi
Number of lanes, N                        2
Free-flow speed:                          Measured
     FFS or BFFS                          70.0          mi/h
Lane width adjustment, fLW                0.0           mi/h
Lateral clearance adjustment, fLC         0.0           mi/h
Interchange density adjustment, fID       0.0           mi/h
Number of lanes adjustment, fN            0.0           mi/h
Free-flow speed, FFS                      70.0          mi/h
                                          Rural Freeway
```

________________________LOS and Performance Measures________________________

```
Flow rate, vp                             688           pc/h/ln
Free-flow speed, FFS                      70.0          mi/h
Average passenger-car speed, S            70.0          mi/h
Number of lanes, N                        2
Density, D                                9.8           pc/mi/ln
Level of service, LOS                     A
```

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

________________________Operational Analysis________________________________

```
Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         3/20/2008 1:45:04 PM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Northbound
From/To:                Sunflower Road to Gardner Road
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study
```

________________________Flow Inputs and Adjustments_________________________

```
Volume, V                                 1450          veh/h
Peak-hour factor, PHF                     0.90
Peak 15-min volume, v15                   403           v
Trucks and buses                          8             %
Recreational vehicles                     0             %
Terrain type:                             Level
    Grade                                 0.00          %
    Segment length                        0.00          mi
Trucks and buses PCE, ET                  1.5
Recreational vehicle PCE, ER              1.2
Heavy vehicle adjustment, fHV             0.962
Driver population factor, fp              1.00
Flow rate, vp                             838           pc/h/ln
```

________________________Speed Inputs and Adjustments________________________

```
Lane width                                12.0          ft
Right-shoulder lateral clearance          6.0           ft
Interchange density                       0.50          interchange/mi
Number of lanes, N                        2
Free-flow speed:                          Measured
     FFS or BFFS                          70.0          mi/h
Lane width adjustment, fLW                0.0           mi/h
Lateral clearance adjustment, fLC         0.0           mi/h
Interchange density adjustment, fID       0.0           mi/h
Number of lanes adjustment, fN            0.0           mi/h
Free-flow speed, FFS                      70.0          mi/h
                                          Rural Freeway
```

________________________LOS and Performance Measures________________________

```
Flow rate, vp                             838           pc/h/ln
Free-flow speed, FFS                      70.0          mi/h
Average passenger-car speed, S            70.0          mi/h
Number of lanes, N                        2
Density, D                                12.0          pc/mi/ln
Level of service, LOS                     B
```

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Wellsville North No Action - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

___Operational Analysis___

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/20/2008 1:45:04 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Gardner Road to US 56
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

___Flow Inputs and Adjustments___

Volume, V	1950	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	542	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1116	pc/h/ln

___Speed Inputs and Adjustments___

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

___LOS and Performance Measures___

Flow rate, vp	1116	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	15.9	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

___Operational Analysis___

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/20/2008 1:45:04 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	US 56 to 151st Street
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

___Flow Inputs and Adjustments___

Volume, V	3260	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	906	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1847	pc/h/ln

___Speed Inputs and Adjustments___

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

___LOS and Performance Measures___

Flow rate, vp	1847	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	67.3	mi/h
Number of lanes, N	2	
Density, D	27.4	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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E-mail:

_____Operational Analysis_____

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/20/2008 1:45:04 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Southbound
From/To: 151Street to US 56
Jurisdiction: KDOT
Analysis Year: 2010
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	1490	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	414	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	865	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	865	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	12.4	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/20/2008 1:45:04 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Southbound
From/To: US 56 to Gardner Road
Jurisdiction: KDOT
Analysis Year: 2010
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	580	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	161	v
Trucks and buses	18	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.917	
Driver population factor, fp	1.00	
Flow rate, vp	351	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	351	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	5.0	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Wellsville North No Action - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_________________________Operational Analysis_________________________

Analyst:	Trishul Palekar	
Agency or Company:	HDR Inc.	
Date Performed:	3/20/2008 1:45:04 PM	
Analysis Time Period:	AM	
Freeway/Direction:	I-35 Southbound	
From/To:	Gardner Road to Sunflower Road	
Jurisdiction:	KDOT	
Analysis Year:	2010	
Description: NEPA Traffic Study		

_________________________Flow Inputs and Adjustments_________________________

Volume, V	530	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	147	v
Trucks and buses	18	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.917	
Driver population factor, fp	1.00	
Flow rate, vp	321	pc/h/ln

_________________________Speed Inputs and Adjustments_________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_________________________LOS and Performance Measures_________________________

Flow rate, vp	321	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	4.6	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_________________________Operational Analysis_________________________

Analyst:	Tom Hiles	
Agency or Company:	HDR Inc.	
Date Performed:	3/27/2008 10:25:01 AM	
Analysis Time Period:	AM	
Freeway/Direction:	I-35 Southbound	
From/To:	Sunflower Road to Edgerton Road	
Jurisdiction:		
Analysis Year:	2010	
Description: NEPA Traffic Study		

_________________________Flow Inputs and Adjustments_________________________

Volume, V	495	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	138	v
Trucks and buses	19	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.913	
Driver population factor, fp	1.00	
Flow rate, vp	301	pc/h/ln

_________________________Speed Inputs and Adjustments_________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_________________________LOS and Performance Measures_________________________

Flow rate, vp	301	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	4.3	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Wellsville North No Action - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	3/27/2008 10:25:01 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Edgerton Road to Sunflower Road
Jurisdiction:	
Analysis Year:	2010
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	695	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	193	v
Trucks and buses	21	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.905	
Driver population factor, fp	1.00	
Flow rate, vp	427	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	427	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	6.1	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/20/2008 1:45:04 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Sunflower Road to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	780	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	217	v
Trucks and buses	19	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.913	
Driver population factor, fp	1.00	
Flow rate, vp	475	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	475	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	6.8	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Wellsville North No Action - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

______Operational Analysis______

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/20/2008 1:45:04 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Gardner Road to US 56
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

______Flow Inputs and Adjustments______

Volume, V	970	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	269	v
Trucks and buses	16	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.926	
Driver population factor, fp	1.00	
Flow rate, vp	582	pc/h/ln

______Speed Inputs and Adjustments______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

______LOS and Performance Measures______

Flow rate, vp	582	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	8.3	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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E-mail:

______Operational Analysis______

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/20/2008 1:45:04 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	US 56 to 151st Street
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

______Flow Inputs and Adjustments______

Volume, V	1850	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	514	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1079	pc/h/ln

______Speed Inputs and Adjustments______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

______LOS and Performance Measures______

Flow rate, vp	1079	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	15.4	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Wellsville North No Action - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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E-mail:

Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/20/2008 1:45:04 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	151Street to US 56
Jurisdiction:	KDOT
Analysis Year:	2010

Description: NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	3090	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	858	v
Trucks and buses	7	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.966	
Driver population factor, fp	1.00	
Flow rate, vp	1777	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	1777	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	68.1	mi/h
Number of lanes, N	2	
Density, D	26.1	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/20/2008 1:45:04 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	US 56 to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2010

Description: NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	2080	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	578	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1208	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	1208	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	17.3	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Wellsville North No Action - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Level of service, LOS B

Overall results are not computed when free-flow speed is less than 55 mph.

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___Operational Analysis___

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/20/2008 1:45:04 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	Gardner Road to Sunflower Road
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

___Flow Inputs and Adjustments___

Volume, V	1630	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	453	v
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.948	
Driver population factor, fp	1.00	
Flow rate, vp	955	pc/h/ln

___Speed Inputs and Adjustments___

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

___LOS and Performance Measures___

Flow rate, vp	955	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	13.6	pc/mi/ln

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Level of service, LOS B

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: Fax:
E-mail:

___Operational Analysis___

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	3/27/2008 10:25:01 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	Sunflower Road to Edgerton Road
Jurisdiction:	
Analysis Year:	2010
Description:	NEPA Traffic Study

___Flow Inputs and Adjustments___

Volume, V	1380	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	383	v
Trucks and buses	13	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.939	
Driver population factor, fp	1.00	
Flow rate, vp	817	pc/h/ln

___Speed Inputs and Adjustments___

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

___LOS and Performance Measures___

Flow rate, vp	817	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	11.7	pc/mi/ln

2010 Wellsville North No Action - AM Peak Hour - HCS Freeway Ramps

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                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:25:01 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         1185           vph

________________________________Off Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0           mph
Volume on ramp                            15             vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

___________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1185        15                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               329         4                    v
Trucks and buses                      9           7                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %            %
     Length                           0.00   mi   0.00    mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.957       0.905
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1376        18                     pcph

________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1376   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1376          4800            No
      Fi   F
     v  = v - v            1358          4800            No
      FO   F   R
     v                     18            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-18)
         12A

_____________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1376          4600                   No
      12                                                                    !
________________Level of Service Determination (if not F)____________________

Density,           D = 4.252 + 0.0086 v  - 0.009  L   =    8.9     pc/mi/ln
                    R                  12          D
Level of service for ramp-freeway junction areas of influence A

______________________________Speed Estimation________________________________

Intermediate speed variable,                 D  = 0.430
                                              S
Space mean speed in ramp influence area,     S  = 58.0    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 58.0    mph
______________________________________________________________________________
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E-mail:

________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:25:01 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         1170           vph

_________________________________On Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0           mph
Volume on ramp                            280            vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

___________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1170        280                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               325         78                   v
Trucks and buses                      9           1                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                                    %           %            %
     Length                                  mi           mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.957       0.985
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1359        316                    pcph

________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1359   pc/h
                   12   F   FM

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1675          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area___________________
                      Actual        Max Desirable          Violation?
     v                1359          4400                   No
      12                                                                    !
________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   13.4    pc/mi/ln
          R                  R            12            A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation________________________________

Intermediate speed variable,                 M  = 0.286
                                              S
Space mean speed in ramp influence area,     S  = 62.0    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.0    mph
______________________________________________________________________________
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2010 Wellsville North No Action - AM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                      Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data____________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1450           vph

_________________________________Off Ramp Data____________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              90             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1450        90                    vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                403         25                    v
Trucks and buses                       8           2                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %             %
     Length                            0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

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Heavy vehicle adjustment, fHV          0.962       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1676        103                       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1676   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v  = v                1676          4800            No
      Fi   F
     v  = v - v            1573          4800            No
      FO   F   R
     v                     103           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                1676          4600                   No
      12                                                                          !
_________________Level of Service Determination (if not F)_____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   11.5    pc/mi/ln
                                         R            12         D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation____________________________________

Intermediate speed variable,                 D  = 0.437
                                              S
Space mean speed in ramp influence area,     S  = 57.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.8    mph
_________________________________________________________________________________
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E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data____________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1360           vph

__________________________________On Ramp Data____________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              590            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1360        590                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                378         164                   v
Trucks and buses                       8           2                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                                     %           %             %
     Length                                    mi          mi            mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.962       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1572        675                       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1572   pc/h
                   12   F   FM

_______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v                     2247          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                1572          4400                   No
      12                                                                          !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   17.7    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation____________________________________

Intermediate speed variable,                 M  = 0.302
                                              S
Space mean speed in ramp influence area,     S  = 61.5    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.5    mph
_________________________________________________________________________________
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2010 Wellsville North No Action - AM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1950           vph

_________________________________Off Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0           mph
Volume on ramp                             240            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1950        240                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                542         67                    v
Trucks and buses                       6           7                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %             %
     Length                            0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.971       0.905
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2232        295                       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2232   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                2232          4800            No
      Fi   F
     v  = v - v            1937          4800            No
      FO   F   R
     v                     295           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34        12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                2232          4600                   No
      12                                                                       !
________________Level of Service Determination (if not F)______________________

Density,            D = 4.252 + 0.0086 v  - 0.009  L   =   16.2    pc/mi/ln
                     R                  12         D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                  D  = 0.455
                                               S
Space mean speed in ramp influence area,      S  = 57.3    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 57.3    mph
________________________________________________________________________________
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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          3129           vph

__________________________________On Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             131            vph
Length of first accel/decel lane           1000           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        3129        131                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                869         36                    v
Trucks and buses                       6           2                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                                     %           %             %
     Length                                    mi          mi            mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.971       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3581        150                       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  3581   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     3731          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34        12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                3581          4400                   No
      12                                                                       !
________________Level of Service Determination (if not F)______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   28.2    pc/mi/ln
          R                  R            12           A
Level of service for ramp-freeway junction areas of influence  D

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                  M  = 0.414
                                               S
Space mean speed in ramp influence area,      S  = 58.4    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 58.4    mph
________________________________________________________________________________
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2010 Wellsville North No Action - AM Peak Hour - HCS Freeway Ramps

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                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1710          vph

_________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            1419          vph
Length of first accel/decel lane          500           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1710        1419                 vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               475         394                  v
Trucks and buses                      6           2                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                                    %           %            %
     Length                                   mi          mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.971       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1957        1624                    pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1957   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum        LOS F?
     v                     3581          4800           No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area___________________
                      Actual        Max Desirable        Violation?
     v                1957          4400                 No
      12                                                                   !
_________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   29.5    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  D

_____________________________Speed Estimation________________________________

Intermediate speed variable,                M  = 0.426
                                             S
Space mean speed in ramp influence area,    S  = 58.1    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 58.1    mph
______________________________________________________________________________
```

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Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               8 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1490          vph

________________________________Off Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   45.0          mph
Volume on ramp                            970           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1490        970                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               414         269                  v
Trucks and buses                      9           3                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %            %
     Length                           0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.957       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1730        1126                    pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1730   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_______________________________

                           Actual        Maximum        LOS F?
     v  = v                1730          4800           No
      Fi   F
     v  = v - v            604           4800           No
      FO   F   R
     v                     1126          2100           No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable        Violation?
     v                1730          4600                 No
      12                                                                   !
_________________Level of Service Determination (if not F)___________________

Density,                D = 4.252 + 0.0086 v  - 0.009  L   =    11.9    pc/mi/ln
                                            R          12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation________________________________

Intermediate speed variable,                D  = 0.399
                                             S
Space mean speed in ramp influence area,    S  = 58.8    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 58.8    mph
______________________________________________________________________________
```

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Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Trishul Palekar
Agency/Co.:	HDR Inc.
Date performed:	3/20/2008 1:45:04 PM
Analysis time period:	AM
Freeway/Dir of Travel:	I-35 Southbound
Junction:	9 US 56 Entr
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	520	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	60	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	520		60			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	144		17			v
Trucks and buses	9		17			%
Recreational vehicles	0		0			%
Terrain type:	Level		Rolling			
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5*		2.5			
Recreational vehicle PCE, ER	1.2*		2.0			
Heavy vehicle adjustment, fHV	0.957		0.797			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	604		84			pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 604 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	688	4800	No
v_3 or v_{av34}	0 pc/h	(Equation 25-4 or 25-5)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} =		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	604	4400	No

!

Level of Service Determination (if not F)

Density, $D = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 5.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable,	M_S = 0.273
Space mean speed in ramp influence area,	S_R = 62.4 mph
Space mean speed in outer lanes,	S_0 = N/A mph
Space mean speed for all vehicles,	S = 62.4 mph

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Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Trishul Palekar
Agency/Co.:	HDR Inc.
Date performed:	3/20/2008 1:45:04 PM
Analysis time period:	AM
Freeway/Dir of Travel:	I-35 Southbound
Junction:	10 Gardner Exit
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	580	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	100	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	580		100			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	161		28			v
Trucks and buses	18		13			%
Recreational vehicles	0		0			%
Terrain type:	Level		Rolling			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5*		2.5			
Recreational vehicle PCE, ER	1.2*		2.0			
Heavy vehicle adjustment, fHV	0.917		0.837			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	702		133			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 702 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	702	4800	No
$v_{FO} = v_F - v_R$	569	4800	No
v_R	133	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} =		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	702	4600	No

!

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 3.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable,	D_S = 0.440
Space mean speed in ramp influence area,	S_R = 57.7 mph
Space mean speed in outer lanes,	S_0 = N/A mph
Space mean speed for all vehicles,	S = 57.7 mph

2010 Wellsville North No Action - AM Peak Hour - HCS Freeway Ramps

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Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          480           vph

__________________________________On Ramp Data___________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0          mph
Volume on ramp                             50            vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

_________________________Adjacent Ramp Data (if one exists)______________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        480         50                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                133         14                   v
Trucks and buses                       18          4                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.917       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          581         59                      pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  581    pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     640           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                581           4400                  No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   5.4     pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.272
                                              S
Space mean speed in ramp influence area,     S  = 62.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.4    mph
________________________________________________________________________________
```

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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

________________________________Diverge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:25:01 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          530           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0          mph
Volume on ramp                             50            vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

_________________________Adjacent Ramp Data (if one exists)______________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        530         50                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                147         14                   v
Trucks and buses                       18          4                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %           %
     Length                            0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.917       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          642         59                      pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  642    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                642           4800            No
      Fi   F
     v  = v - v            583           4800            No
      FO   F   R
     v                     59            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                642           4600                  No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   2.6     pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.433
                                              S
Space mean speed in ramp influence area,     S  = 57.9    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.9    mph
________________________________________________________________________________
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2010 Wellsville North No Action - AM Peak Hour - HCS Freeway Ramps

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                   HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                       Fax:
E-mail:

________________________________Merge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:25:01 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           480            vph

_________________________________On Ramp Data________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              15             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

___________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        480         15                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                133         4                    v
Trucks and buses                       18          0                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.917       1.000
Driver population factor, fP           1.00        1.00
Flow rate, vp                          581         17                   pcph

_________________________Estimation of V12 Merge Areas_______________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  581    pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     598           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                581           4400                  No
      12                                                                    !
_________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   5.1     pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation________________________________

Intermediate speed variable,                 M  = 0.272
                                              S
Space mean speed in ramp influence area,     S  = 62.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.4    mph
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Phone:                                    Fax:
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_________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:25:01 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           695            vph

_________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              15             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         695         15                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 193         4                    v
Trucks and buses                        20          0                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
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Heavy vehicle adjustment, fHV          0.909       1.000
Driver population factor, fP           1.00        1.00
Flow rate, vp                          849         17                      pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  849    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                849           4800            No
      Fi   F
     v  = v - v            832           4800            No
      FO   F   R
     v                     17            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                849           4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   4.4     pc/mi/ln
                      R                  12          D
Level of service for ramp-freeway junction areas of influence A

______________________________Speed Estimation__________________________________

Intermediate speed variable,                D  = 0.430
                                             S
Space mean speed in ramp influence area,    S  = 58.0    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 58.0    mph
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Phone:                                    Fax:
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_________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:25:01 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           680            vph

__________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              100            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         680         100                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 189         28                   v
Trucks and buses                        20          4                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
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Heavy vehicle adjustment, fHV          0.909       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          831         118                     pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  831    pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     949           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                831           4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   7.8     pc/mi/ln
          R                  R            12            A
Level of service for ramp-freeway junction areas of influence  A

______________________________Speed Estimation__________________________________

Intermediate speed variable,                M  = 0.275
                                             S
Space mean speed in ramp influence area,    S  = 62.3    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 62.3    mph
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2010 Wellsville North No Action - PM Peak Hour - HCS Freeway Ramps

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Phone:                                      Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:25:01 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           780           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              60            vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)______________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         780         60                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 217         17                  v
Trucks and buses                        18          7                   %
Recreational vehicles                   0           0                   %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %           %
     Length                             0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
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Heavy vehicle adjustment, fHV           0.917       0.905
Driver population factor, fP            1.00        1.00
Flow rate, vp                           945         74                      pcph

_________________________Estimation of V12 Diverge Areas_________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  945    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v  = v                945           4800            No
      Fi   F
     v  = v - v            871           4800            No
      FO   F   R
     v                     74            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_______________________
                      Actual        Max Desirable         Violation?
     v                945           4600                  No
      12                                                                       !
_________________Level of Service Determination (if not F)_______________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   5.2     pc/mi/ln
                                         R             12      D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation____________________________________

Intermediate speed variable,                 D  = 0.435
                                              S
Space mean speed in ramp influence area,     S  = 57.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.8    mph
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Phone:                                      Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:25:01 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           720           vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              250           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)______________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         720         250                 vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 200         69                  v
Trucks and buses                        18          6                   %
Recreational vehicles                   0           0                   %
Terrain type:                           Level       Rolling
     Grade                                      %           %           %
     Length                                     mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
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Heavy vehicle adjustment, fHV           0.917       0.917
Driver population factor, fP            1.00        1.00
Flow rate, vp                           872         303                     pcph

_________________________Estimation of V12 Merge Areas___________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  872    pc/h
                   12   F   FM

_______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v                     1175          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area________________________
                      Actual        Max Desirable         Violation?
     v                872           4400                  No
      12                                                                       !
_________________Level of Service Determination (if not F)_______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   9.5     pc/mi/ln
                              R            12           A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation____________________________________

Intermediate speed variable,                 M  = 0.278
                                              S
Space mean speed in ramp influence area,     S  = 62.2    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.2    mph
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Phone:                                     Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           970            vph

_________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              120            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         970         120                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 269         33                    v
Trucks and buses                        16          8                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %             %
     Length                             0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.926       0.893
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1164        149                   pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1164   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1164          4800            No
      Fi   F
     v  = v - v            1015          4800            No
      FO   F   R
     v                     149           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v   =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1164          4600                   No
      12                                                                      !
________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   7.1     pc/mi/ln
                                         R           12      D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.441
                                              S
Space mean speed in ramp influence area,     S  = 57.6    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.6    mph
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_________________________________Merge Analysis__________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1826           vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              24             vph
Length of first accel/decel lane            1000           ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1826        24                    vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 507         7                     v
Trucks and buses                        16          3                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                                      %           %             %
     Length                                     mi          mi            mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.926       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2191        28                    pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2191   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2219          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v   =                            (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2191          4400                   No
      12                                                                      !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   16.5    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.287
                                              S
Space mean speed in ramp influence area,     S  = 62.0    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.0    mph
_______________________________________________________________________________
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Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         850           vph

__________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            976           vph
Length of first accel/decel lane          500           ft
Length of second accel/decel lane                       ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       850         976                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               236         271                   v
Trucks and buses                      16          3                     %
Recreational vehicles                 0           0                     %
Terrain type:                         Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
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Heavy vehicle adjustment, fHV          0.926       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1020        1133                    pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1020   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2153          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v         > 2700 pc/h?        No
      3 or  av34
Is   v     v         > 1.5 v  /2         No
      3 or  av34            12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                1020          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   18.6    pc/mi/ln
          R                    R           12           A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.320
                                              S
Space mean speed in ramp influence area,     S  = 61.1    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.1    mph
_______________________________________________________________________________
```

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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               8 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         3090          vph

_________________________________Off Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   45.0          mph
Volume on ramp                            1320          vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       3090        1320                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               858         367                   v
Trucks and buses                      7           2                     %
Recreational vehicles                 0           0                     %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %           %
     Length                           0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.966       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3553        1511                    pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  3553   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                3553          4800            No
      Fi   F
     v  = v - v            2042          4800            No
      FO   F   R
     v                     1511          2100            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v         > 2700 pc/h?        No
      3 or  av34
Is   v     v         > 1.5 v  /2         No
      3 or  av34            12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                3553          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   27.6    pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.434
                                              S
Space mean speed in ramp influence area,     S  = 57.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.8    mph
_______________________________________________________________________________
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                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis_________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               9 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1770          vph

__________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            310           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1770        310                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               492         86                     v
Trucks and buses                      7           3                      %
Recreational vehicles                 0           0                      %
Terrain type:                         Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.966       0.957
Driver population factor, fP          1.00        1.00
Flow rate, vp                         2035        360                     pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2035   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     2395          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v           > 2700 pc/h?          No
      3 or  av34
Is   v     v           > 1.5 v  /2           No
      3 or  av34             12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                2035          4400                  No
      12                                                                     !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   19.0    pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                M  = 0.308
                                             S
Space mean speed in ramp influence area,    S  = 61.4    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 61.4    mph
________________________________________________________________________________
```

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                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis_______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         2080          vph

_________________________________Off Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            540           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       2080        540                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               578         150                    v
Trucks and buses                      9           4                      %
Recreational vehicles                 0           0                      %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %           %
     Length                           0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.957       0.943
Driver population factor, fP          1.00        1.00
Flow rate, vp                         2415        636                     pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2415   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                2415          4800            No
      Fi   F
     v  = v - v            1779          4800            No
      FO   F   R
     v                     636           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v           > 2700 pc/h?          No
      3 or  av34
Is   v     v           > 1.5 v  /2           No
      3 or  av34             12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                2415          4600                  No
      12                                                                     !
_________________Level of Service Determination (if not F)_____________________

Density,                D = 4.252 + 0.0086 v  - 0.009  L   =   17.8    pc/mi/ln
                         R                 12           D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                D  = 0.485
                                             S
Space mean speed in ramp influence area,    S  = 56.4    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 56.4    mph
________________________________________________________________________________
```

2010 Wellsville North No Action - PM Peak Hour - HCS Freeway Ramps

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                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/20/2008 1:45:04 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                         Merge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0          mph
Volume on freeway                        1540          vph

__________________________________On Ramp Data_________________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-flow speed on ramp                  35.0          mph
Volume on ramp                           90            vph
Length of first accel/decel lane         800           ft
Length of second accel/decel lane                      ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                No
Volume on adjacent Ramp                                vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                              ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                  Freeway     Ramp        Adjacent
                                                             Ramp
Volume, V (vph)                      1540        90                   vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              428         25                   v
Trucks and buses                     9           6                    %
Recreational vehicles                0           0                    %
Terrain type:                        Level       Rolling
     Grade                                   %           %            %
     Length                                  mi          mi           mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
Heavy vehicle adjustment, fHV            0.957       0.917
Driver population factor, fP             1.00        1.00
Flow rate, vp                            1788        109                     pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1788   pc/h
                   12   F   FM

________________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v                     1897          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                1788          4400                  No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   15.2    pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.291
                                              S
Space mean speed in ramp influence area,     S  = 61.9    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.9    mph
_______________________________________________________________________________
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                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:25:01 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                         Diverge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0          mph
Volume on freeway                        1630          vph

_________________________________Off Ramp Data_________________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-Flow speed on ramp                  35.0          mph
Volume on ramp                           280           vph
Length of first accel/decel lane         800           ft
Length of second accel/decel lane                      ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                No
Volume on adjacent ramp                                vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                              ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                  Freeway     Ramp        Adjacent
                                                             Ramp
Volume, V (vph)                      1630        280                  vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              453         78                   v
Trucks and buses                     11          1                    %
Recreational vehicles                0           0                    %
Terrain type:                        Level       Rolling
     Grade                           0.00    %   0.00    %            %
     Length                          0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
Heavy vehicle adjustment, fHV            0.948       0.985
Driver population factor, fP             1.00        1.00
Flow rate, vp                            1911        316                     pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1911   pc/h
                   12   R     F   R   FD

________________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v  = v                1911          4800            No
      Fi   F
     v  = v - v            1595          4800            No
      FO   F   R
     v                     316           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                1911          4600                  No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   13.5    pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.456
                                              S
Space mean speed in ramp influence area,     S  = 57.2    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.2    mph
_______________________________________________________________________________
```

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                     Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:25:01 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1350           vph

__________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              30             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1350        30                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                375         8                    v
Trucks and buses                       11          7                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.948       0.905
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1583        37                       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1583   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1620          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1583          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   13.1    pc/mi/ln
          R                  R           12            A
Level of service for ramp-freeway junction areas of influence  B

________________________________Speed Estimation_______________________________

Intermediate speed variable,                M  = 0.285
                                             S
Space mean speed in ramp influence area,    S  = 62.0    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 62.0    mph
_______________________________________________________________________________
```

2010 Wellsville North Alternative - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_______________________Operational Analysis_______________________________

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 2:16:37 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Edgerton Road to Sunflower Road
Jurisdiction:	
Analysis Year:	2010
Description:	NEPA Traffic Study

_______________________Flow Inputs and Adjustments_______________________

Volume, V	1205	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	335	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	700	pc/h/ln

_______________________Speed Inputs and Adjustments_______________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______________________LOS and Performance Measures_______________________

Flow rate, vp	700	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	10.0	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

_______________________Operational Analysis_______________________________

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 2:16:37 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Sunflower Road to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

_______________________Flow Inputs and Adjustments_______________________

Volume, V	1570	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	436	v
Trucks and buses	12	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.943	
Driver population factor, fp	1.00	
Flow rate, vp	925	pc/h/ln

_______________________Speed Inputs and Adjustments_______________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______________________LOS and Performance Measures_______________________

Flow rate, vp	925	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	13.2	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Wellsville North Alternative - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Level of service, LOS B

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 4/2/2008 2:16:37 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: Gardner Road to US 56
Jurisdiction: KDOT
Analysis Year: 2010
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	2070	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	575	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1208	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	1208	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	17.3	pc/mi/ln

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Level of service, LOS D

Overall results are not computed when free-flow speed is less than 55 mph.

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_____Operational Analysis_____

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 4/2/2008 2:16:37 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: US 56 to 151st Street
Jurisdiction: KDOT
Analysis Year: 2010
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	3380	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	939	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1934	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	1934	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	66.0	mi/h
Number of lanes, N	2	
Density, D	29.3	pc/mi/ln

2010 Wellsville North Alternative - AM Peak Hour - HCS Freeway Mainline

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_______Operational Analysis_______

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 2:16:37 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	151Street to US 56
Jurisdiction:	KDOT
Analysis Year:	2010
Description: NEPA Traffic Study	

_______Flow Inputs and Adjustments_______

Volume, V	1570	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	436	v
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.948	
Driver population factor, fp	1.00	
Flow rate, vp	920	pc/h/ln

_______Speed Inputs and Adjustments_______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______LOS and Performance Measures_______

Flow rate, vp	920	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	13.1	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

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_______Operational Analysis_______

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 2:16:37 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	US 56 to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2010
Description: NEPA Traffic Study	

_______Flow Inputs and Adjustments_______

Volume, V	670	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	186	v
Trucks and buses	23	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.897	
Driver population factor, fp	1.00	
Flow rate, vp	415	pc/h/ln

_______Speed Inputs and Adjustments_______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______LOS and Performance Measures_______

Flow rate, vp	415	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	5.9	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

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___Operational Analysis___

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 2:16:37 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	Gardner Road to Sunflower Road
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

___Flow Inputs and Adjustments___

Volume, V	620	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	172	v
Trucks and buses	24	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.893	
Driver population factor, fp	1.00	
Flow rate, vp	386	pc/h/ln

___Speed Inputs and Adjustments___

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

___LOS and Performance Measures___

Flow rate, vp	386	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	5.5	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

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___Operational Analysis___

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 2:16:37 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	Sunflower Road to Edgerton Road
Jurisdiction:	
Analysis Year:	2010
Description:	NEPA Traffic Study

___Flow Inputs and Adjustments___

Volume, V	495	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	138	v
Trucks and buses	19	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.913	
Driver population factor, fp	1.00	
Flow rate, vp	301	pc/h/ln

___Speed Inputs and Adjustments___

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

___LOS and Performance Measures___

Flow rate, vp	301	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	4.3	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Wellsville North Alternative - PM Peak Hour - HCS Freeway Mainline

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_________________________Operational Analysis__________________________________

Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         4/2/2008 2:16:37 PM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Northbound
From/To:                Edgerton Road to Sunflower Road
Jurisdiction:
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                   685            veh/h
Peak-hour factor, PHF                       0.90
Peak 15-min volume, v15                     190            v
Trucks and buses                            21             %
Recreational vehicles                       0              %
Terrain type:                               Level
    Grade                                   0.00           %
    Segment length                          0.00           mi
Trucks and buses PCE, ET                    1.5
Recreational vehicle PCE, ER                1.2
Heavy vehicle adjustment, fHV               0.905
Driver population factor, fp                1.00
Flow rate, vp                               421            pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                  12.0           ft
Right-shoulder lateral clearance            6.0            ft
Interchange density                         0.50           interchange/mi
Number of lanes, N                          2
Free-flow speed:                            Measured
     FFS or BFFS                            70.0           mi/h
Lane width adjustment, fLW                  0.0            mi/h
Lateral clearance adjustment, fLC           0.0            mi/h
Interchange density adjustment, fID         0.0            mi/h
Number of lanes adjustment, fN              0.0            mi/h
Free-flow speed, FFS                        70.0           mi/h
                                            Rural Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                               421            pc/h/ln
Free-flow speed, FFS                        70.0           mi/h
Average passenger-car speed, S              70.0           mi/h
Number of lanes, N                          2
Density, D                                  6.0            pc/mi/ln
Level of service, LOS                       A

  Overall results are not computed when free-flow speed is less than 55 mph.
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_________________________Operational Analysis__________________________________

Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         4/2/2008 2:16:37 PM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Northbound
From/To:                Sunflower Road to Gardner Road
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                   850            veh/h
Peak-hour factor, PHF                       0.90
Peak 15-min volume, v15                     236            v
Trucks and buses                            25             %
Recreational vehicles                       0              %
Terrain type:                               Level
    Grade                                   0.00           %
    Segment length                          0.00           mi
Trucks and buses PCE, ET                    1.5
Recreational vehicle PCE, ER                1.2
Heavy vehicle adjustment, fHV               0.889
Driver population factor, fp                1.00
Flow rate, vp                               531            pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                  12.0           ft
Right-shoulder lateral clearance            6.0            ft
Interchange density                         0.50           interchange/mi
Number of lanes, N                          2
Free-flow speed:                            Measured
     FFS or BFFS                            70.0           mi/h
Lane width adjustment, fLW                  0.0            mi/h
Lateral clearance adjustment, fLC           0.0            mi/h
Interchange density adjustment, fID         0.0            mi/h
Number of lanes adjustment, fN              0.0            mi/h
Free-flow speed, FFS                        70.0           mi/h
                                            Rural Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                               531            pc/h/ln
Free-flow speed, FFS                        70.0           mi/h
Average passenger-car speed, S              70.0           mi/h
Number of lanes, N                          2
Density, D                                  7.6            pc/mi/ln
Level of service, LOS                       A

  Overall results are not computed when free-flow speed is less than 55 mph.
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2010 Wellsville North Alternative - PM Peak Hour - HCS Freeway Mainline

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_______________________Operational Analysis_______________________

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 2:16:37 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Gardner Road to US 56
Jurisdiction:	KDOT
Analysis Year:	2010

Description: NEPA Traffic Study

_______________________Flow Inputs and Adjustments_______________________

Volume, V	1040	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	289	v
Trucks and buses	22	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.901	
Driver population factor, fp	1.00	
Flow rate, vp	641	pc/h/ln

_______________________Speed Inputs and Adjustments_______________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______________________LOS and Performance Measures_______________________

Flow rate, vp	641	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	9.2	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

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_______________________Operational Analysis_______________________

Analyst:	Trishul Palekar
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Date Performed:	4/2/2008 2:16:37 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	US 56 to 151st Street
Jurisdiction:	KDOT
Analysis Year:	2010

Description: NEPA Traffic Study

_______________________Flow Inputs and Adjustments_______________________

Volume, V	1920	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	533	v
Trucks and buses	13	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.939	
Driver population factor, fp	1.00	
Flow rate, vp	1136	pc/h/ln

_______________________Speed Inputs and Adjustments_______________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______________________LOS and Performance Measures_______________________

Flow rate, vp	1136	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	16.2	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

Level of service, LOS D

Overall results are not computed when free-flow speed is less than 55 mph.

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________________________Operational Analysis__________________________________

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Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         4/2/2008 2:16:37 PM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Southbound
From/To:                151Street to US 56
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study
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________________________Flow Inputs and Adjustments___________________________

Volume, V	3180	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	883	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1846	pc/h/ln

________________________Speed Inputs and Adjustments__________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

________________________LOS and Performance Measures__________________________

Flow rate, vp	1846	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	67.3	mi/h
Number of lanes, N	2	
Density, D	27.4	pc/mi/ln

Level of service, LOS C

Overall results are not computed when free-flow speed is less than 55 mph.

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________________________Operational Analysis__________________________________

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Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         4/2/2008 2:16:37 PM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Southbound
From/To:                US 56 to Gardner Road
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study
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________________________Flow Inputs and Adjustments___________________________

Volume, V	2170	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	603	v
Trucks and buses	13	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.939	
Driver population factor, fp	1.00	
Flow rate, vp	1284	pc/h/ln

________________________Speed Inputs and Adjustments__________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

________________________LOS and Performance Measures__________________________

Flow rate, vp	1284	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	18.3	pc/mi/ln

2010 Wellsville North Alternative - PM Peak Hour - HCS Freeway Mainline

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Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 2:16:37 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	Gardner Road to Sunflower Road
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	1720	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	478	v
Trucks and buses	15	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.930	
Driver population factor, fp	1.00	
Flow rate, vp	1027	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	1027	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	14.7	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 2:16:37 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	Sunflower Road to Edgerton Road
Jurisdiction:	
Analysis Year:	2010
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	1385	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	385	v
Trucks and buses	12	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.943	
Driver population factor, fp	1.00	
Flow rate, vp	816	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	816	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	11.7	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2010 Wellsville North Alternative - AM Peak Hour - HCS Freeway Ramps

```
                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:               Trishul Palekar
Agency/Co.:            HDR Inc.
Date performed:        4/2/2008 2:16:37 PM
Analysis time period:  AM
Freeway/Dir of Travel: I-35 Northbound
Junction:              1 Sunflower Exit
Jurisdiction:          KDOT
Analysis Year:         2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1205          vph

________________________________Off Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            25            vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1205        25                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               335         7                    v
Trucks and buses                      9           12                   %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %            %
     Length                           0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.957       0.847
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1399        33                   pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =           (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1399   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                            Actual        Maximum         LOS F?
     v  = v                 1399          4800            No
      Fi   F
     v  = v - v             1366          4800            No
      FO   F   R
     v                      33            2000            No
      R
     v     v                0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?            No
      3 or  av34
Is   v     v      > 1.5 v  /2             No
      3 or  av34         12
If yes, v    =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                       Actual        Max Desirable          Violation?
     v                 1399          4600                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =    9.1     pc/mi/ln
                        R                  12        D
Level of service for ramp-freeway junction areas of influence A

______________________________Speed Estimation________________________________

Intermediate speed variable,                  D  = 0.431
                                               S
Space mean speed in ramp influence area,      S  = 57.9    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 57.9    mph
______________________________________________________________________________
```

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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:               Trishul Palekar
Agency/Co.:            HDR Inc.
Date performed:        4/2/2008 2:16:37 PM
Analysis time period:  AM
Freeway/Dir of Travel: I-35 Northbound
Junction:              2 Sunflower Entr
Jurisdiction:          KDOT
Analysis Year:         2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1180          vph

_________________________________On Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            390           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1180        390                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               328         108                  v
Trucks and buses                      9           20                   %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                                    %           %            %
     Length                                   mi          mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.957       0.769
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1370        563                  pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =           (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1370   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                            Actual        Maximum         LOS F?
     v                      1933          4800            No
      FO
     v     v                0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?            No
      3 or  av34
Is   v     v      > 1.5 v  /2             No
      3 or  av34         12
If yes, v    =                            (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                       Actual        Max Desirable          Violation?
     v                 1370          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   15.3    pc/mi/ln
          R                   R            12           A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation________________________________

Intermediate speed variable,                  M  = 0.292
                                               S
Space mean speed in ramp influence area,      S  = 61.8    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 61.8    mph
______________________________________________________________________________
```

2010 Wellsville North Alternative - AM Peak Hour - HCS Freeway Ramps

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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         1570           vph

________________________________Off Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0           mph
Volume on ramp                            90             vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp       Adjacent
                                                             Ramp
Volume, V (vph)                       1570        90                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               436         25                   v
Trucks and buses                      12          2                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %            %
     Length                           0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.943       0.971
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1849        103                     pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1849   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1849          4800            No
      Fi   F
     v  = v - v            1746          4800            No
      FO   F   R
     v                     103           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable           Violation?
     v                1849          4600                    No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density,            D = 4.252 + 0.0086 v  - 0.009  L   =   13.0    pc/mi/ln
                         R                 12         D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.437
                                              S
Space mean speed in ramp influence area,     S  = 57.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.8    mph
_______________________________________________________________________________
```

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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

________________________________Merge Analysis__________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         1480           vph

_________________________________On Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0           mph
Volume on ramp                            590            vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp       Adjacent
                                                             Ramp
Volume, V (vph)                       1480        590                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               411         164                  v
Trucks and buses                      12          2                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                                    %           %            %
     Length                                   mi          mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.943       0.971
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1743        675                     pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1743   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2418          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable           Violation?
     v                1743          4400                    No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   19.0    pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.309
                                              S
Space mean speed in ramp influence area,     S  = 61.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.4    mph
_______________________________________________________________________________
```

2010 Wellsville North Alternative - AM Peak Hour - HCS Freeway Ramps

HCS+: Ramps and Ramp Junctions Release 5.21

Phone: Fax:
E-mail:

Diverge Analysis

Analyst: Trishul Palekar
Agency/Co.: HDR Inc.
Date performed: 4/2/2008 2:16:37 PM
Analysis time period: AM
Freeway/Dir of Travel: I-35 Northbound
Junction: 5 US-56 Exit
Jurisdiction: KDOT
Analysis Year: 2010
Description: NEPA Traffic Study

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	2070	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	240	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	2070		240			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	575		67			v
Trucks and buses	10		8			%
Recreational vehicles	0		0			%
Terrain type:	Level		Rolling			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5*		2.5			
Recreational vehicle PCE, ER	1.2*		2.0			
Heavy vehicle adjustment, fHV	0.952		0.893			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	2415		299			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2415 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	2415	4800	No
$v_{FO} = v_F - v_R$	2116	4800	No
v_R	299	2000	No
v_{3} or v_{av34}	0 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} =		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2415	4600	No

!

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 17.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	D_S = 0.455	
Space mean speed in ramp influence area,	S_R = 57.3	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 57.3	mph

HCS+: Ramps and Ramp Junctions Release 5.21

Phone: Fax:
E-mail:

Merge Analysis

Analyst: Trishul Palekar
Agency/Co.: HDR Inc.
Date performed: 4/2/2008 2:16:37 PM
Analysis time period: AM
Freeway/Dir of Travel: I-35 Northbound
Junction: 6 US-56 Entr
Jurisdiction: KDOT
Analysis Year: 2010
Description: NEPA Traffic Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	3250	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	130	vph
Length of first accel/decel lane	1000	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	3250		130			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	903		36			v
Trucks and buses	10		2			%
Recreational vehicles	0		0			%
Terrain type:	Level		Rolling			
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5*		2.5			
Recreational vehicle PCE, ER	1.2*		2.0			
Heavy vehicle adjustment, fHV	0.952		0.971			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	3792		149			pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 3792 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3941	4800	No
v_3 or v_{av34}	0 pc/h	(Equation 25-4 or 25-5)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} =		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3792	4400	No

!

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 29.9 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	M_S = 0.452	
Space mean speed in ramp influence area,	S_R = 57.4	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 57.4	mph

2010 Wellsville North Alternative - AM Peak Hour - HCS Freeway Ramps

```
                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1830           vph

__________________________________On Ramp Data_______________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              1420           vph
Length of first accel/decel lane            500            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1830        1420                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                508         394                  v
Trucks and buses                       10          2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.952       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2135        1625                    pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2135   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     3760          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                2135          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   30.9    pc/mi/ln
          R                  R           12            A
Level of service for ramp-freeway junction areas of influence  D

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.453
                                              S
Space mean speed in ramp influence area,     S  = 57.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.3    mph
_______________________________________________________________________________
```

```
                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis____________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               8 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1570           vph

_________________________________Off Ramp Data_______________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     45.0           mph
Volume on ramp                              970            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1570        970                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                436         269                  v
Trucks and buses                       11          3                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %           %
     Length                            0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.948       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1840        1126                    pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1840   pc/h
                   12   R      F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1840          4800            No
      Fi   F
     v  = v - v            714           4800            No
      FO   F   R
     v                     1126          2100            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1840          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   12.9    pc/mi/ln
                                         R           12          D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.399
                                              S
Space mean speed in ramp influence area,     S  = 58.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 58.8    mph
_______________________________________________________________________________
```

2010 Wellsville North Alternative - AM Peak Hour - HCS Freeway Ramps

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                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Merge Analysis_______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               9 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         600           vph

_________________________________On Ramp Data________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            70            vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       600         70                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               167         19                   v
Trucks and buses                      11          17                   %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
    Grade                                     %           %            %
    Length                                    mi          mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.948       0.797
Driver population factor, fP          1.00        1.00
Flow rate, vp                         703         98                       pcph

_________________________Estimation of V12 Merge Areas_______________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  703    pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     801           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area___________________
                      Actual        Max Desirable          Violation?
     v                703           4400                   No
      12                                                                     !
________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   6.7     pc/mi/ln
                              R            12           A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation________________________________

Intermediate speed variable,                 M  = 0.274
                                              S
Space mean speed in ramp influence area,     S  = 62.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.3    mph
_____________________________________________________________________________
```

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Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis_____________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         670           vph

________________________________Off Ramp Data________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            100           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       670         100                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               186         28                   v
Trucks and buses                      23          13                   %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
    Grade                             0.00    %   0.00    %            %
    Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.897       0.837
Driver population factor, fP          1.00        1.00
Flow rate, vp                         830         133                      pcph

_________________________Estimation of V12 Diverge Areas_____________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  830    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v  = v                830           4800            No
      Fi   F
     v  = v - v            697           4800            No
      FO   F   R
     v                     133           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area__________________
                      Actual        Max Desirable          Violation?
     v                830           4600                   No
      12                                                                     !
________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   4.2     pc/mi/ln
                                        R         12         D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation________________________________

Intermediate speed variable,                 D  = 0.440
                                              S
Space mean speed in ramp influence area,     S  = 57.7    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.7    mph
_____________________________________________________________________________
```

2010 Wellsville North Alternative - AM Peak Hour - HCS Freeway Ramps

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                      HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                     Fax:
E-mail:

________________________________Merge Analysis_______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          570            vph

_________________________________On Ramp Data________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             50             vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        570         50                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                158         14                   v
Trucks and buses                       23          4                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.897       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          706         59                   pcph

________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  706    pc/h
                   12   F   FM

______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v                     765           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                706           4400                   No
      12                                                                   !
________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   6.4     pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  A

____________________________Speed Estimation_________________________________

Intermediate speed variable,              M  = 0.273
                                           S
Space mean speed in ramp influence area,  S  = 62.3    mph
                                           R
Space mean speed in outer lanes,          S  =  N/A    mph
                                           0
Space mean speed for all vehicles,        S  = 62.3    mph
_____________________________________________________________________________
```

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                      HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                     Fax:
E-mail:

________________________________Diverge Analysis_____________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          620            vph

________________________________Off Ramp Data________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0           mph
Volume on ramp                             140            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        620         140                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                172         39                   v
Trucks and buses                       24          0                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.893       1.000
Driver population factor, fP           1.00        1.00
Flow rate, vp                          772         156                  pcph

________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  772    pc/h
                   12   R      F   R   FD

______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v  = v                772           4800            No
      Fi   F
     v  = v - v            616           4800            No
      FO   F   R
     v                     156           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area__________________
                      Actual        Max Desirable          Violation?
     v                772           4600                   No
      12                                                                   !
________________Level of Service Determination (if not F)___________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =    3.7     pc/mi/ln
                                          R           12        D
Level of service for ramp-freeway junction areas of influence A

____________________________Speed Estimation_________________________________

Intermediate speed variable,              D  = 0.442
                                           S
Space mean speed in ramp influence area,  S  = 57.6    mph
                                           R
Space mean speed in outer lanes,          S  =  N/A    mph
                                           0
Space mean speed for all vehicles,        S  = 57.6    mph
_____________________________________________________________________________
```

2010 Wellsville North Alternative - AM Peak Hour - HCS Freeway Ramps

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                HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                     Fax:
E-mail:

_________________________________Merge Analysis_______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           480            vph

__________________________________On Ramp Data________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              15             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        480         15                    vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                133         4                     v
Trucks and buses                       24          13                    %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                                     %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.893       0.837
Driver population factor, fP           1.00        1.00
Flow rate, vp                          597         20                    pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  597    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     617           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                597           4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   5.3     pc/mi/ln
          R                  R            12            A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.272
                                              S
Space mean speed in ramp influence area,     S  = 62.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.4    mph
________________________________________________________________________________
```

2010 Wellsville North Alternative - PM Peak Hour - HCS Freeway Ramps

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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                  Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          685            vph

________________________________Off Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0           mph
Volume on ramp                             15             vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        685         15                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                190         4                    v
Trucks and buses                       21          20                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.905       0.769
Driver population factor, fP           1.00        1.00
Flow rate, vp                          841         22                          pcph

________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  841    pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                841           4800            No
      Fi   F
     v  = v - v            819           4800            No
      FO   F   R
     v                     22            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34        12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable           Violation?
     v                841           4600                    No
      12                                                                        !
_________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   4.3     pc/mi/ln
                       R                   12         D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation_________________________________

Intermediate speed variable,               D  = 0.430
                                            S
Space mean speed in ramp influence area,   S  = 58.0    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 58.0    mph
_______________________________________________________________________________
```

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Phone:                                  Fax:
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________________________________Merge Analysis_________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          670            vph

_________________________________On Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             180            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        670         180                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                186         50                   v
Trucks and buses                       21          0                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.905       1.000
Driver population factor, fP           1.00        1.00
Flow rate, vp                          823         200                         pcph

________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  823    pc/h
                   12   F   FM

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1023          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34        12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable           Violation?
     v                823           4400                    No
      12                                                                        !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   8.3     pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation_________________________________

Intermediate speed variable,               M  = 0.276
                                            S
Space mean speed in ramp influence area,   S  = 62.3    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 62.3    mph
_______________________________________________________________________________
```

2010 Wellsville North Alternative - PM Peak Hour - HCS Freeway Ramps

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Phone:                                    Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          850            vph

________________________________Off Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0           mph
Volume on ramp                             60             vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        850         60                    vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                236         17                    v
Trucks and buses                       25          7                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
    Grade                              0.00    %   0.00    %             %
    Length                             0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.889       0.905
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1063        74                    pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1063   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1063          4800            No
      Fi   F
     v  = v - v            989           4800            No
      FO   F   R
     v                     74            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1063          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,            D = 4.252 + 0.0086 v  - 0.009  L   =    6.2     pc/mi/ln
                     R                  12          D
Level of service for ramp-freeway junction areas of influence A

______________________________Speed Estimation_________________________________

Intermediate speed variable,                 D  = 0.435
                                              S
Space mean speed in ramp influence area,     S  = 57.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.8    mph
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Phone:                                    Fax:
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________________________________Merge Analysis_________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          790            vph

_________________________________On Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             250            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        790         250                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                219         69                    v
Trucks and buses                       25          6                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
    Grade                                      %           %             %
    Length                                     mi          mi            mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.889       0.917
Driver population factor, fP           1.00        1.00
Flow rate, vp                          988         303                   pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  988    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1291          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                988           4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   10.4    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation_________________________________

Intermediate speed variable,                 M  = 0.279
                                              S
Space mean speed in ramp influence area,     S  = 62.2    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.2    mph
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________________________________Diverge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1040           vph

________________________________Off Ramp Data_________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0           mph
Volume on ramp                             120            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1040        120                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                289         33                   v
Trucks and buses                       22          11                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.901       0.858
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1283        155                       pcph

________________________Estimation of V12 Diverge Areas______________________

                 L  =            (Equation 25-8 or 25-9)
                  EQ
                 P  =    1.000   Using Equation  0
                  FD
                 v  = v  + (v - v ) P  =  1283   pc/h
                  12   R     F   R   FD

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1283          4800            No
      Fi   F
     v  = v - v            1128          4800            No
      FO   F   R
     v                     155           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable          Violation?
     v                1283          4600                   No
      12                                                                       !
_________________Level of Service Determination (if not F)____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   8.1     pc/mi/ln
                      R                  12          D
Level of service for ramp-freeway junction areas of influence A

____________________________Speed Estimation__________________________________

Intermediate speed variable,                D  = 0.442
                                             S
Space mean speed in ramp influence area,    S  = 57.6    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.6    mph
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________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1900           vph

_________________________________On Ramp Data_________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             20             vph
Length of first accel/decel lane           1000           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1900        20                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                528         6                    v
Trucks and buses                       22          3                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.901       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2343        23                        pcph

________________________Estimation of V12 Merge Areas_________________________

                 L  =            (Equation 25-2 or 25-3)
                  EQ
                 P  =    1.000   Using Equation  0
                  FM
                 v  = v  (P  ) =  2343   pc/h
                  12   F   FM

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2366          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                2343          4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   17.6    pc/mi/ln
          R                   R            12           A
Level of service for ramp-freeway junction areas of influence  B

____________________________Speed Estimation__________________________________

Intermediate speed variable,                M  = 0.293
                                             S
Space mean speed in ramp influence area,    S  = 61.8    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 61.8    mph
______________________________________________________________________________
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2010 Wellsville North Alternative - PM Peak Hour - HCS Freeway Ramps

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_______________________________Merge Analysis_______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

________________________________Freeway Data________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         920           vph

________________________________On Ramp Data________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            980           vph
Length of first accel/decel lane          500           ft
Length of second accel/decel lane                       ft

______________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

________________Conversion to pc/h Under Base Conditions_________________

Junction Components                    Freeway    Ramp       Adjacent
                                                             Ramp
Volume, V (vph)                        920        980                 vph
Peak-hour factor, PHF                  0.90       0.90
Peak 15-min volume, v15                256        272                 v
Trucks and buses                       22         3                   %
Recreational vehicles                  0          0                   %
Terrain type:                          Level      Rolling
    Grade                                     %          %          %
    Length                                    mi         mi         mi
Trucks and buses PCE, ET               1.5*       2.5
Recreational vehicle PCE, ER           1.2*       2.0
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Heavy vehicle adjustment, fHV          0.901      0.957
Driver population factor, fP           1.00       1.00
Flow rate, vp                          1135       1138                   pcph

_______________________Estimation of V12 Merge Areas______________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1135   pc/h
                   12   F   FM

____________________________Capacity Checks____________________________

                           Actual        Maximum         LOS F?
     v                     2273          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area___________________
                      Actual        Max Desirable          Violation?
     v                1135          4400                   No
      12                                                                    !
_______________Level of Service Determination (if not F)__________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   19.5    pc/mi/ln
                              R            12            A
Level of service for ramp-freeway junction areas of influence  B

___________________________Speed Estimation_________________________________

Intermediate speed variable,              M  = 0.324
                                           S
Space mean speed in ramp influence area,  S  = 60.9    mph
                                           R
Space mean speed in outer lanes,          S  =  N/A    mph
                                           0
Space mean speed for all vehicles,        S  = 60.9    mph
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_______________________________Diverge Analysis_____________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               8 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

________________________________Freeway Data________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         3180          vph

_______________________________Off Ramp Data________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   45.0          mph
Volume on ramp                            1320          vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

______________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

________________Conversion to pc/h Under Base Conditions_________________

Junction Components                    Freeway    Ramp       Adjacent
                                                             Ramp
Volume, V (vph)                        3180       1320                vph
Peak-hour factor, PHF                  0.90       0.90
Peak 15-min volume, v15                883        367                 v
Trucks and buses                       9          2                   %
Recreational vehicles                  0          0                   %
Terrain type:                          Level      Rolling
    Grade                              0.00    %  0.00    %           %
    Length                             0.00   mi  0.00    mi          mi
Trucks and buses PCE, ET               1.5*       2.5
Recreational vehicle PCE, ER           1.2*       2.0
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Heavy vehicle adjustment, fHV          0.957      0.971
Driver population factor, fP           1.00       1.00
Flow rate, vp                          3692       1511                   pcph

_______________________Estimation of V12 Diverge Areas____________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  3692   pc/h
                   12   R     F   R   FD

____________________________Capacity Checks____________________________

                           Actual        Maximum         LOS F?
     v  = v                3692          4800            No
      Fi   F
     v  = v - v            2181          4800            No
      FO   F   R
     v                     1511          2100            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

____________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable          Violation?
     v                3692          4600                   No
      12                                                                    !
_______________Level of Service Determination (if not F)__________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   28.8    pc/mi/ln
                                          R           12         D
Level of service for ramp-freeway junction areas of influence D

___________________________Speed Estimation_________________________________

Intermediate speed variable,              D  = 0.434
                                           S
Space mean speed in ramp influence area,  S  = 57.8    mph
                                           R
Space mean speed in outer lanes,          S  =  N/A    mph
                                           0
Space mean speed for all vehicles,        S  = 57.8    mph
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________________________________Merge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               9 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          1860          vph

_________________________________On Ramp Data_______________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0          mph
Volume on ramp                             310           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions_______________

Junction Components                    Freeway     Ramp       Adjacent
                                                              Ramp
Volume, V (vph)                        1860        310                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                517         86                  v
Trucks and buses                       9           4                   %
Recreational vehicles                  0           0                   %
Terrain type:                          Level       Rolling
    Grade                                      %          %          %
    Length                                     mi         mi         mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.957       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2160        365                   pcph

_________________________Estimation of V12 Merge Areas_______________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2160   pc/h
                   12   F   FM

______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     2525          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area___________________
                      Actual        Max Desirable         Violation?
     v                2160          4400                  No
      12                                                                    !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   20.0-   pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

____________________________Speed Estimation________________________________

Intermediate speed variable,              M  = 0.314
                                           S
Space mean speed in ramp influence area,  S  = 61.2    mph
                                           R
Space mean speed in outer lanes,          S  =  N/A    mph
                                           0
Space mean speed for all vehicles,        S  = 61.2    mph
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Phone:                                  Fax:
E-mail:

________________________________Diverge Analysis____________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          2170          vph

________________________________Off Ramp Data_______________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0          mph
Volume on ramp                             540           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions_______________

Junction Components                    Freeway     Ramp       Adjacent
                                                              Ramp
Volume, V (vph)                        2170        540                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                603         150                 v
Trucks and buses                       13          4                   %
Recreational vehicles                  0           0                   %
Terrain type:                          Level       Rolling
    Grade                              0.00    %   0.00   %          %
    Length                             0.00    mi  0.00   mi         mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.939       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2568        636                   pcph

_________________________Estimation of V12 Diverge Areas_____________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2568   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v  = v                2568          4800            No
      Fi   F
     v  = v - v            1932          4800            No
      FO   F   R
     v                     636           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable         Violation?
     v                2568          4600                  No
      12                                                                    !
_________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   19.1    pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation________________________________

Intermediate speed variable,              D  = 0.485
                                           S
Space mean speed in ramp influence area,  S  = 56.4    mph
                                           R
Space mean speed in outer lanes,          S  =  N/A    mph
                                           0
Space mean speed for all vehicles,        S  = 56.4    mph
____________________________________________________________________________
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2010 Wellsville North Alternative - PM Peak Hour - HCS Freeway Ramps

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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1630           vph

__________________________________On Ramp Data___________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             90             vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1630        90                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                453         25                   v
Trucks and buses                       13          6                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.939       0.917
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1929        109                  pcph

________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1929   pc/h
                   12   F   FM

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2038          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v         > 2700 pc/h?        No
      3 or  av34
Is   v     v         > 1.5 v  /2         No
      3 or  av34            12
If yes, v    =                           (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area___________________
                      Actual        Max Desirable          Violation?
     v                1929          4400                   No
      12                                                                  !
________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   16.3    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.295
                                              S
Space mean speed in ramp influence area,     S  = 61.7    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.7    mph
_______________________________________________________________________________
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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1720           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0           mph
Volume on ramp                             370            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1720        370                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                478         103                  v
Trucks and buses                       15          25                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %           %
     Length                            0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.930       0.727
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2054        565                  pcph

________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2054   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                2054          4800            No
      Fi   F
     v  = v - v            1489          4800            No
      FO   F   R
     v                     565           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v         > 2700 pc/h?        No
      3 or  av34
Is   v     v         > 1.5 v  /2         No
      3 or  av34            12
If yes, v    =                           (Equation 25-18)
         12A

____________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable          Violation?
     v                2054          4600                   No
      12                                                                  !
________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   14.7    pc/mi/ln
                                         R            12          D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.479
                                              S
Space mean speed in ramp influence area,     S  = 56.6    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 56.6    mph
_______________________________________________________________________________
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2010 Wellsville North Alternative - PM Peak Hour - HCS Freeway Ramps

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                  HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1350           vph

__________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              35             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1350        35                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                375         10                   v
Trucks and buses                       15          11                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
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Heavy vehicle adjustment, fHV          0.930       0.858
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1612        45                   pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1612   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1657          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1612          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   13.4    pc/mi/ln
          R                  R           12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                  M  = 0.285
                                               S
Space mean speed in ramp influence area,      S  = 62.0    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 62.0    mph
_______________________________________________________________________________
```

2015 Wellsville North No Action - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/24/2008 10:31:41 AM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Edgerton Road to Sunflower Road
Jurisdiction:	
Analysis Year:	2015
Description:	NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	1295	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	360	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	755	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	755	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	10.8	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/24/2008 10:31:41 AM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Sunflower Road to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2015
Description:	NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	1700	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	472	v
Trucks and buses	8	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.962	
Driver population factor, fp	1.00	
Flow rate, vp	982	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	982	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	14.0	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2015 Wellsville North No Action - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/24/2008 10:31:41 AM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: Gardner Road to US 56
Jurisdiction: KDOT
Analysis Year: 2015
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	2270	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	631	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1299	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	1299	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	18.6	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/24/2008 10:31:41 AM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: US 56 to 151st Street
Jurisdiction: KDOT
Analysis Year: 2015
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	3770	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1047	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	2136	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	2136	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	61.8	mi/h
Number of lanes, N	2	
Density, D	34.5	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/24/2008 10:31:41 AM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	151Street to US 56
Jurisdiction:	KDOT
Analysis Year:	2015
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	1710	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	475	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	993	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	993	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	14.2	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/24/2008 10:31:41 AM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	US 56 to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2015
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	670	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	186	v
Trucks and buses	18	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.917	
Driver population factor, fp	1.00	
Flow rate, vp	406	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	406	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	5.8	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/24/2008 10:31:41 AM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	Gardner Road to Sunflower Road
Jurisdiction:	KDOT
Analysis Year:	2015
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	620	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	172	v
Trucks and buses	18	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.917	
Driver population factor, fp	1.00	
Flow rate, vp	375	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	375	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	5.4	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/24/2008 10:31:41 AM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	Sunflower Road to Edgerton Road
Jurisdiction:	
Analysis Year:	2015
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	555	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	154	v
Trucks and buses	18	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.917	
Driver population factor, fp	1.00	
Flow rate, vp	336	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	336	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	4.8	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	3/27/2008 10:03:18 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Edgerton Road to Sunflower Road
Jurisdiction:	
Analysis Year:	2015
Description:	NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	775	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	215	v
Trucks and buses	21	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.905	
Driver population factor, fp	1.00	
Flow rate, vp	476	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	476	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	6.8	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/24/2008 10:31:41 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Sunflower Road to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2015
Description:	NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	910	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	253	v
Trucks and buses	18	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.917	
Driver population factor, fp	1.00	
Flow rate, vp	551	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	551	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	7.9	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

2015 Wellsville North No Action - PM Peak Hour - HCS Freeway Mainline

Level of service, LOS A

HCS+: Basic Freeway Segments Release 5.21

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/24/2008 10:31:41 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Gardner Road to US 56
Jurisdiction:	KDOT
Analysis Year:	2015
Description:	NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	1130	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	314	v
Trucks and buses	16	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.926	
Driver population factor, fp	1.00	
Flow rate, vp	678	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	678	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	9.7	pc/mi/ln

Level of service, LOS B

HCS+: Basic Freeway Segments Release 5.21

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/24/2008 10:31:41 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	US 56 to 151st Street
Jurisdiction:	KDOT
Analysis Year:	2015
Description:	NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	2140	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	594	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1242	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	1242	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	17.7	pc/mi/ln

2015 Wellsville North No Action - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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E-mail:

______Operational Analysis______

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/24/2008 10:31:41 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	151Street to US 56
Jurisdiction:	KDOT
Analysis Year:	2015
Description:	NEPA Traffic Study

______Flow Inputs and Adjustments______

Volume, V	3580	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	994	v
Trucks and buses	7	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.966	
Driver population factor, fp	1.00	
Flow rate, vp	2058	pc/h/ln

______Speed Inputs and Adjustments______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

______LOS and Performance Measures______

Flow rate, vp	2058	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	63.7	mi/h
Number of lanes, N	2	
Density, D	32.3	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

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______Operational Analysis______

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	3/24/2008 10:31:41 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	US 56 to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2015
Description:	NEPA Traffic Study

______Flow Inputs and Adjustments______

Volume, V	2420	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	672	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1405	pc/h/ln

______Speed Inputs and Adjustments______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

______LOS and Performance Measures______

Flow rate, vp	1405	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	20.1	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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_____Operational Analysis_____

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 3/24/2008 10:31:41 AM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: Gardner Road to Sunflower Road
Jurisdiction: KDOT
Analysis Year: 2015
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	1910	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	531	v
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.948	
Driver population factor, fp	1.00	
Flow rate, vp	1119	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	1119	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	16.0	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 3/27/2008 10:03:18 AM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: Sunflower Road to Edgerton Road
Jurisdiction:
Analysis Year: 2015
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	1530	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	425	v
Trucks and buses	13	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.939	
Driver population factor, fp	1.00	
Flow rate, vp	905	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	905	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	12.9	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2015 Wellsville North No Action - AM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:03:18 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         1295           vph

________________________________Off Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0           mph
Volume on ramp                            25             vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1295        25                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               360         7                    v
Trucks and buses                      10          4                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %            %
     Length                           0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.952       0.943
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1511        29                   pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1511   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                1511          4800            No
      Fi   F
     v  = v - v            1482          4800            No
      FO   F   R
     v                     29            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                1511          4600                  No
      12                                                                      !
________________Level of Service Determination (if not F)_____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   10.0+   pc/mi/ln
                                 R             12         D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation_________________________________

Intermediate speed variable,                 D  = 0.431
                                              S
Space mean speed in ramp influence area,     S  = 57.9    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.9    mph
_______________________________________________________________________________
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Phone:                                   Fax:
E-mail:

________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:03:18 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         1270           vph

_________________________________On Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0           mph
Volume on ramp                            430            vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1270        430                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               353         119                  v
Trucks and buses                      10          1                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                                    %           %            %
     Length                                   mi          mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.952       0.985
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1482        485                  pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1482   pc/h
                   12   F   FM

______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     1967          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                1482          4400                  No
      12                                                                      !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   15.6    pc/mi/ln
                              R            12           A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation_________________________________

Intermediate speed variable,                 M  = 0.293
                                              S
Space mean speed in ramp influence area,     S  = 61.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.8    mph
_______________________________________________________________________________
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2015 Wellsville North No Action - AM Peak Hour - HCS Freeway Ramps

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                  HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data____________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1700          vph

_________________________________Off Ramp Data____________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            110           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

_________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1700        110                 vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               472         31                  v
Trucks and buses                      8           2                   %
Recreational vehicles                 0           0                   %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %           %
     Length                           0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.962       0.971
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1964        126                     pcph

_________________________Estimation of V12 Diverge Areas________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1964   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v  = v                1964          4800            No
      Fi   F
     v  = v - v            1838          4800            No
      FO   F   R
     v                     126           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                1964          4600                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   13.9    pc/mi/ln
                                         R            12        D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation___________________________________

Intermediate speed variable,                   D  = 0.439
                                                S
Space mean speed in ramp influence area,       S  = 57.7    mph
                                                R
Space mean speed in outer lanes,               S  =  N/A    mph
                                                0
Space mean speed for all vehicles,             S  = 57.7    mph
________________________________________________________________________________
```

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Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data____________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1590          vph

__________________________________On Ramp Data____________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            680           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

_________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1590        680                 vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               442         189                 v
Trucks and buses                      8           2                   %
Recreational vehicles                 0           0                   %
Terrain type:                         Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.962       0.971
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1837        778                     pcph

_________________________Estimation of V12 Merge Areas__________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1837   pc/h
                   12   F   FM

_______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v                     2615          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                1837          4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   20.5    pc/mi/ln
                              R            12             A
Level of service for ramp-freeway junction areas of influence  C

______________________________Speed Estimation___________________________________

Intermediate speed variable,                   M  = 0.318
                                                S
Space mean speed in ramp influence area,       S  = 61.1    mph
                                                R
Space mean speed in outer lanes,               S  =  N/A    mph
                                                0
Space mean speed for all vehicles,             S  = 61.1    mph
________________________________________________________________________________
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2015 Wellsville North No Action - AM Peak Hour - HCS Freeway Ramps

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Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data____________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           2270           vph

_________________________________Off Ramp Data____________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              270            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        2270        270                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                631         75                    v
Trucks and buses                       6           7                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.971       0.905
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2598        332                   pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2598   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                2598          4800            No
      Fi   F
     v  = v - v            2266          4800            No
      FO   F   R
     v                     332           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34          12
If yes, v   =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2598          4600                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density,           D = 4.252 + 0.0086 v  - 0.009  L   =   19.4    pc/mi/ln
                    R                   12         D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                D  = 0.458
                                             S
Space mean speed in ramp influence area,    S  = 57.2    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.2    mph
________________________________________________________________________________
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Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data____________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           3630           vph

__________________________________On Ramp Data____________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              140            vph
Length of first accel/decel lane            1000           ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        3630        140                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                1008        39                    v
Trucks and buses                       6           2                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.971       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          4154        160                   pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  4154   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     4314          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34          12
If yes, v   =                            (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                4154          4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   32.8    pc/mi/ln
               R             R          12           A
Level of service for ramp-freeway junction areas of influence  D

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                M  = 0.542
                                             S
Space mean speed in ramp influence area,    S  = 54.8    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 54.8    mph
________________________________________________________________________________
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2015 Wellsville North No Action - AM Peak Hour - HCS Freeway Ramps

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                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis_______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         2000          vph

__________________________________On Ramp Data________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            1630          vph
Length of first accel/decel lane          500           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        2000        1630                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                556         453                  v
Trucks and buses                       6           2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                 %           %           %
     Length                                mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.971       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2289        1865                 pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2289   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v                     4154          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                2289          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   33.9    pc/mi/ln
          R                   R           12           A
Level of service for ramp-freeway junction areas of influence  D

_______________________________Speed Estimation_______________________________

Intermediate speed variable,                 M  = 0.534
                                              S
Space mean speed in ramp influence area,     S  = 55.0    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 55.0    mph
_______________________________________________________________________________
```

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Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis_____________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               8 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1710          vph

_________________________________Off Ramp Data________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   45.0          mph
Volume on ramp                            1120          vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1710        1120                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                475         311                  v
Trucks and buses                       9           3                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %           %
     Length                            0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.957       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1986        1300                 pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1986   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v  = v                1986          4800            No
      Fi   F
     v  = v - v            686           4800            No
      FO   F   R
     v                     1300          2100            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1986          4600                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   14.1    pc/mi/ln
                                         R           12          D
Level of service for ramp-freeway junction areas of influence B

_______________________________Speed Estimation_______________________________

Intermediate speed variable,                 D  = 0.415
                                              S
Space mean speed in ramp influence area,     S  = 58.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 58.4    mph
_______________________________________________________________________________
```

2015 Wellsville North No Action - AM Peak Hour - HCS Freeway Ramps

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                 HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:03:18 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               9 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         590           vph

_________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            80            vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

___________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       590         80                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               164         22                   v
Trucks and buses                      9           14                   %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
    Grade                                     %           %            %
    Length                                    mi          mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.957       0.826
Driver population factor, fP          1.00        1.00
Flow rate, vp                         685         108                   pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  685    pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum        LOS F?
     v                     793           4800           No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable        Violation?
     v                685           4400                 No
      12                                                                 !
________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   6.6    pc/mi/ln
                              R             12           A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation_________________________________

Intermediate speed variable,               M  = 0.274
                                            S
Space mean speed in ramp influence area,   S  = 62.3    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 62.3    mph
______________________________________________________________________________
```

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                 HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
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________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:03:18 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         670           vph

________________________________Off Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            110           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

___________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       670         110                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               186         31                   v
Trucks and buses                      18          12                   %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
    Grade                             0.00    %   0.00    %            %
    Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.917       0.847
Driver population factor, fP          1.00        1.00
Flow rate, vp                         811         144                   pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  811    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                           Actual        Maximum        LOS F?
     v  = v                811           4800           No
      Fi   F
     v  = v - v            667           4800           No
      FO   F   R
     v                     144           2000           No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

_____________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable        Violation?
     v                811           4600                 No
      12                                                                 !
________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   4.0     pc/mi/ln
                                          R          12        D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation_________________________________

Intermediate speed variable,               D  = 0.441
                                            S
Space mean speed in ramp influence area,   S  = 57.7    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 57.7    mph
______________________________________________________________________________
```

2015 Wellsville North No Action - AM Peak Hour - HCS Freeway Ramps

HCS+: Ramps and Ramp Junctions Release 5.21

Phone: Fax:
E-mail:

Merge Analysis

Analyst: Tom Hiles
Agency/Co.: HDR Inc.
Date performed: 3/27/2008 10:03:18 AM
Analysis time period: AM
Freeway/Dir of Travel: I-35 Southbound
Junction: 11 Gardner Entr
Jurisdiction: KDOT
Analysis Year: 2015
Description: NEPA Traffic Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	560	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	60	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	560	60		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	156	17		v
Trucks and buses	18	3		%
Recreational vehicles	0	0		%
Terrain type:	Level	Rolling		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5*	2.5		
Recreational vehicle PCE, ER	1.2*	2.0		
Heavy vehicle adjustment, fHV	0.917	0.957		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	678	70		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)
P_{FM} = 1.000 Using Equation 0
$v_{12} = v_F (P_{FM})$ = 678 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	748	4800	No
v_{3} or v_{av34}	0 pc/h	(Equation 25-4 or 25-5)	
Is v_{3} or v_{av34} > 2700 pc/h?		No	
Is v_{3} or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} =		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	678	4400	No

!

Level of Service Determination (if not F)

Density, $D = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 6.3 pc/mi/ln
Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable, M_S = 0.273
Space mean speed in ramp influence area, S_R = 62.3 mph
Space mean speed in outer lanes, S_0 = N/A mph
Space mean speed for all vehicles, S = 62.3 mph

HCS+: Ramps and Ramp Junctions Release 5.21

Phone: Fax:
E-mail:

Diverge Analysis

Analyst: Tom Hiles
Agency/Co.: HDR Inc.
Date performed: 3/27/2008 10:03:18 AM
Analysis time period: AM
Freeway/Dir of Travel: I-35 Southbound
Junction: 12 Sunflower Exit
Jurisdiction: KDOT
Analysis Year: 2015
Description: NEPA Traffic Study

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	620	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	90	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	620	90		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	172	25		v
Trucks and buses	18	2		%
Recreational vehicles	0	0		%
Terrain type:	Level	Rolling		
Grade	0.00 %	0.00 %	%	
Length	0.00 mi	0.00 mi	mi	
Trucks and buses PCE, ET	1.5*	2.5		
Recreational vehicle PCE, ER	1.2*	2.0		
Heavy vehicle adjustment, fHV	0.917	0.971		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	751	103		pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)
P_{FD} = 1.000 Using Equation 0
$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 751 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	751	4800	No
$v_{FO} = v_F - v_R$	648	4800	No
v_R	103	2000	No
v_{3} or v_{av34}	0 pc/h	(Equation 25-15 or 25-16)	
Is v_{3} or v_{av34} > 2700 pc/h?		No	
Is v_{3} or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} =		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	751	4600	No

!

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 3.5 pc/mi/ln
Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable, D_S = 0.437
Space mean speed in ramp influence area, S_R = 57.8 mph
Space mean speed in outer lanes, S_0 = N/A mph
Space mean speed for all vehicles, S = 57.8 mph

2015 Wellsville North No Action - AM Peak Hour - HCS Freeway Ramps

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                  HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           530            vph

__________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              25             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         530         25                    vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 147         7                     v
Trucks and buses                        18          0                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                                      %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.917       1.000
Driver population factor, fP            1.00        1.00
Flow rate, vp                           642         28                    pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  642    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     670           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                642           4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   5.7     pc/mi/ln
          R                    R            12            A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.273
                                              S
Space mean speed in ramp influence area,     S  = 62.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.4    mph
_______________________________________________________________________________
```

2015 Wellsville North No Action - PM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:                 Tom Hiles
Agency/Co.:              HDR Inc.
Date performed:          3/27/2008 10:03:18 AM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                1 Sunflower Exit
Jurisdiction:            KDOT
Analysis Year:           2015
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          775            vph

________________________________Off Ramp Data_________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0           mph
Volume on ramp                             25             vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

___________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        775         25                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                215         7                    v
Trucks and buses                       21          0                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.905       1.000
Driver population factor, fP           1.00        1.00
Flow rate, vp                          952         28                     pcph

________________________Estimation of V12 Diverge Areas______________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  952    pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_________________________________

                            Actual        Maximum         LOS F?
     v  = v                 952           4800            No
      Fi   F
     v  = v - v             924           4800            No
      FO   F   R
     v                      28            2000            No
      R
     v     v                0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?           No
      3 or  av34
Is   v     v       > 1.5 v  /2            No
      3 or  av34          12
If yes, v    =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                       Actual        Max Desirable          Violation?
     v                 952           4600                   No
      12                                                                     !
________________Level of Service Determination (if not F)____________________

Density,            D = 4.252 + 0.0086 v  - 0.009  L   =   5.2     pc/mi/ln
                     R                  12          D
Level of service for ramp-freeway junction areas of influence A

______________________________Speed Estimation________________________________

Intermediate speed variable,                D  = 0.431
                                             S
Space mean speed in ramp influence area,    S  = 57.9    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.9    mph
______________________________________________________________________________
```

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Phone:                                   Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                 Tom Hiles
Agency/Co.:              HDR Inc.
Date performed:          3/27/2008 10:03:18 AM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                2 Sunflower Entr
Jurisdiction:            KDOT
Analysis Year:           2015
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          750            vph

_________________________________On Ramp Data_________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             160            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

___________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        750         160                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                208         44                   v
Trucks and buses                       21          3                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.905       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          921         186                    pcph

________________________Estimation of V12 Merge Areas________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  921    pc/h
                   12   F   FM

______________________________Capacity Checks_________________________________

                            Actual        Maximum         LOS F?
     v                      1107          4800            No
      FO
     v     v                0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?           No
      3 or  av34
Is   v     v       > 1.5 v  /2            No
      3 or  av34          12
If yes, v    =                            (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area____________________
                       Actual        Max Desirable          Violation?
     v                 921           4400                   No
      12                                                                     !
________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   9.0     pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  A

______________________________Speed Estimation________________________________

Intermediate speed variable,                M  = 0.277
                                             S
Space mean speed in ramp influence area,    S  = 62.2    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 62.2    mph
______________________________________________________________________________
```

2015 Wellsville North No Action - PM Peak Hour - HCS Freeway Ramps

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                       HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                       Fax:
E-mail:

_________________________________Diverge Analysis______________________________

Analyst:                 Tom Hiles
Agency/Co.:              HDR Inc.
Date performed:          3/27/2008 10:03:18 AM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                3 Gardner Exit
Jurisdiction:            KDOT
Analysis Year:           2015
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                             Diverge
Number of lanes in freeway                   2
Free-flow speed on freeway                   70.0           mph
Volume on freeway                            910            vph

_________________________________Off Ramp Data__________________________________

Side of freeway                              Right
Number of lanes in ramp                      1
Free-Flow speed on ramp                      35.0           mph
Volume on ramp                               70             vph
Length of first accel/decel lane             800            ft
Length of second accel/decel lane                           ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                    No
Volume on adjacent ramp                                     vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                   ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                      Freeway     Ramp        Adjacent
                                                                 Ramp
Volume, V (vph)                          910         70                    vph
Peak-hour factor, PHF                    0.90        0.90
Peak 15-min volume, v15                  253         19                    v
Trucks and buses                         18          6                     %
Recreational vehicles                    0           0                     %
Terrain type:                            Level       Rolling
     Grade                               0.00    %   0.00    %             %
     Length                              0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET                 1.5*        2.5
Recreational vehicle PCE, ER             1.2*        2.0
```

```
Heavy vehicle adjustment, fHV            0.917        0.917
Driver population factor, fP             1.00         1.00
Flow rate, vp                            1102         85                       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1102   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1102          4800            No
      Fi   F
     v  = v - v            1017          4800            No
      FO   F   R
     v                     85            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1102          4600                   No
      12                                                                       !
_________________Level of Service Determination (if not F)____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =    6.5     pc/mi/ln
                                         R               12       D
Level of service for ramp-freeway junction areas of influence A

________________________________Speed Estimation________________________________

Intermediate speed variable,                 D  = 0.436
                                              S
Space mean speed in ramp influence area,     S  = 57.8     mph
                                              R
Space mean speed in outer lanes,             S  =  N/A     mph
                                              0
Space mean speed for all vehicles,           S  = 57.8     mph
________________________________________________________________________________
```

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                       HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                       Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          3/24/2008 10:31:41 AM
Analysis time period:    PM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                4 Gardner Entr
Jurisdiction:            KDOT
Analysis Year:           2015
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                             Merge
Number of lanes in freeway                   2
Free-flow speed on freeway                   70.0           mph
Volume on freeway                            840            vph

__________________________________On Ramp Data__________________________________

Side of freeway                              Right
Number of lanes in ramp                      1
Free-flow speed on ramp                      35.0           mph
Volume on ramp                               290            vph
Length of first accel/decel lane             800            ft
Length of second accel/decel lane                           ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                    No
Volume on adjacent Ramp                                     vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                   ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                      Freeway     Ramp        Adjacent
                                                                 Ramp
Volume, V (vph)                          840         290                   vph
Peak-hour factor, PHF                    0.90        0.90
Peak 15-min volume, v15                  233         81                    v
Trucks and buses                         18          6                     %
Recreational vehicles                    0           0                     %
Terrain type:                            Level       Rolling
     Grade                                       %           %             %
     Length                                      mi          mi            mi
Trucks and buses PCE, ET                 1.5*        2.5
Recreational vehicle PCE, ER             1.2*        2.0
```

```
Heavy vehicle adjustment, fHV            0.917        0.917
Driver population factor, fP             1.00         1.00
Flow rate, vp                            1017         351                      pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1017   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1368          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1017          4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   11.0    pc/mi/ln
                              R              12            A
Level of service for ramp-freeway junction areas of influence  B

________________________________Speed Estimation________________________________

Intermediate speed variable,                 M  = 0.280
                                              S
Space mean speed in ramp influence area,     S  = 62.2     mph
                                              R
Space mean speed in outer lanes,             S  =  N/A     mph
                                              0
Space mean speed for all vehicles,           S  = 62.2     mph
________________________________________________________________________________
```

2015 Wellsville North No Action - PM Peak Hour - HCS Freeway Ramps

```
                 HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                     Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1130           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              130            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1130        130                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                314         36                    v
Trucks and buses                       16          8                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                             0.00     %  0.00     %            %
     Length                            0.00     mi 0.00     mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.926       0.893
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1356        162                   pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1356   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v  = v                1356          4800            No
      Fi   F
     v  = v - v            1194          4800            No
      FO   F   R
     v                     162           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_______________________
                       Actual        Max Desirable           Violation?
     v                 1356          4600                    No
      12                                                                        !
_________________Level of Service Determination (if not F)______________________

Density,           D = 4.252 + 0.0086 v  - 0.009  L   =   8.7     pc/mi/ln
                                       R          12       D
Level of service for ramp-freeway junction areas of influence A

______________________________Speed Estimation____________________________________

Intermediate speed variable,                 D  = 0.443
                                              S
Space mean speed in ramp influence area,     S  = 57.6    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.6    mph
_________________________________________________________________________________
```

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                 HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                     Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           2120           vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              20             vph
Length of first accel/decel lane            1000           ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        2120        20                    vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                589         6                     v
Trucks and buses                       16          3                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.926       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2544        23                    pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2544   pc/h
                   12   F   FM

_______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v                     2567          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_______________________
                       Actual        Max Desirable           Violation?
     v                 2544          4400                    No
      12                                                                        !
_________________Level of Service Determination (if not F)______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   19.2    pc/mi/ln
                              R          12           A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation____________________________________

Intermediate speed variable,                 M  = 0.302
                                              S
Space mean speed in ramp influence area,     S  = 61.5    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.5    mph
_________________________________________________________________________________
```

2015 Wellsville North No Action - PM Peak Hour - HCS Freeway Ramps

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                  HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Merge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                         Merge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0          mph
Volume on freeway                        1000          vph

_________________________________On Ramp Data_______________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-flow speed on ramp                  35.0          mph
Volume on ramp                           1120          vph
Length of first accel/decel lane         500           ft
Length of second accel/decel lane                      ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                No
Volume on adjacent Ramp                                vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                              ft

____________________Conversion to pc/h Under Base Conditions________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1000        1120                 vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               278         311                  v
Trucks and buses                      16          3                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.926       0.957
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1200        1300                  pcph

_________________________Estimation of V12 Merge Areas_______________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1200   pc/h
                   12   F   FM

______________________________Capacity Checks________________________________

                           Actual        Maximum        LOS F?
     v                     2500          4800           No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v         > 2700 pc/h?           No
      3 or  av34
Is   v     v         > 1.5 v  /2            No
      3 or  av34            12
If yes, v    =                              (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area____________________
                      Actual       Max Desirable        Violation?
     v                1200         4400                 No
      12                                                                   !
_________________Level of Service Determination (if not F)__________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   21.2    pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  C

______________________________Speed Estimation_______________________________

Intermediate speed variable,                  M  = 0.334
                                               S
Space mean speed in ramp influence area,      S  = 60.7    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 60.7    mph
_____________________________________________________________________________
```

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                  HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis____________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               8 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                         Diverge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0          mph
Volume on freeway                        3580          vph

________________________________Off Ramp Data_______________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-Flow speed on ramp                  45.0          mph
Volume on ramp                           1520          vph
Length of first accel/decel lane         800           ft
Length of second accel/decel lane                      ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                No
Volume on adjacent ramp                                vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                              ft

____________________Conversion to pc/h Under Base Conditions________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       3580        1520                 vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               994         422                  v
Trucks and buses                      7           2                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %           %
     Length                           0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.966       0.971
Driver population factor, fP          1.00        1.00
Flow rate, vp                         4117        1740                  pcph

_________________________Estimation of V12 Diverge Areas_____________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  4117   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks________________________________

                           Actual        Maximum        LOS F?
     v  = v                4117          4800           No
      Fi   F
     v  = v - v            2377          4800           No
      FO   F   R
     v                     1740          2100           No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v         > 2700 pc/h?           No
      3 or  av34
Is   v     v         > 1.5 v  /2            No
      3 or  av34            12
If yes, v    =                              (Equation 25-18)
         12A

_______________________Flow Entering Diverge Influence Area__________________
                      Actual       Max Desirable        Violation?
     v                4117         4600                 No
      12                                                                   !
_________________Level of Service Determination (if not F)__________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =    32.5     pc/mi/ln
                                          R           12          D
Level of service for ramp-freeway junction areas of influence D

______________________________Speed Estimation_______________________________

Intermediate speed variable,                  D  = 0.455
                                               S
Space mean speed in ramp influence area,      S  = 57.3    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 57.3    mph
_____________________________________________________________________________
```

```
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Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis_________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               9 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         2060           vph

__________________________________On Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0           mph
Volume on ramp                            360            vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       2060        360                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               572         100                  v
Trucks and buses                      7           3                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.966       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2369        418                     pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2369   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2787          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2369          4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   22.0    pc/mi/ln
          R                    R           12            A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                  M  = 0.328
                                               S
Space mean speed in ramp influence area,      S  = 60.8    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 60.8    mph
_______________________________________________________________________________
```

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Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0           mph
Volume on freeway                         2420           vph

_________________________________Off Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0           mph
Volume on ramp                            620            vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       2420        620                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               672         172                  v
Trucks and buses                      9           4                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %           %
     Length                           0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.957       0.943
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2810        730                     pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2810   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                2810          4800            No
      Fi   F
     v  = v - v            2080          4800            No
      FO   F   R
     v                     730           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2810          4600                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   21.2    pc/mi/ln
                            R                  12          D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                  D  = 0.494
                                               S
Space mean speed in ramp influence area,      S  = 56.2    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 56.2    mph
_______________________________________________________________________________
```

```
                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                     Fax:
E-mail:

_________________________________Merge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          1800          vph

__________________________________On Ramp Data_______________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0          mph
Volume on ramp                             110           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

_________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1800        110                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                500         31                   v
Trucks and buses                       9           6                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.957       0.917
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2090        133                  pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2090   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     2223          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                2090          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   17.7    pc/mi/ln
          R                   R          12             A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation________________________________

Intermediate speed variable,                 M  = 0.301
                                              S
Space mean speed in ramp influence area,     S  = 61.6    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.6    mph
_____________________________________________________________________________
```

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                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                     Fax:
E-mail:

_________________________________Diverge Analysis____________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         3/24/2008 10:31:41 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          1910          vph

_________________________________Off Ramp Data_______________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0          mph
Volume on ramp                             440           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

_________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1910        440                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                531         122                  v
Trucks and buses                       11          1                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.948       0.985
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2239        496                  pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2239   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v  = v                2239          4800            No
      Fi   F
     v  = v - v            1743          4800            No
      FO   F   R
     v                     496           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                2239          4600                   No
      12                                                                     !
_________________Level of Service Determination (if not F)___________________

Density,                D = 4.252 + 0.0086 v  - 0.009  L   =   16.3    pc/mi/ln
                                            R           12       D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation________________________________

Intermediate speed variable,                 D  = 0.473
                                              S
Space mean speed in ramp influence area,     S  = 56.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 56.8    mph
_____________________________________________________________________________
```

```
                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                     Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:03:18 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1910           vph

________________________________Off Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0           mph
Volume on ramp                             420            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1910        420                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                531         117                  v
Trucks and buses                       11          1                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.948       0.985
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2239        474                    pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2239   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                2239          4800            No
      Fi   F
     v  = v - v            1765          4800            No
      FO   F   R
     v                     474           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2239          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density,          D = 4.252 + 0.0086 v  - 0.009  L   =   16.3    pc/mi/ln
                                      R             12          D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation_________________________________

Intermediate speed variable,                D  = 0.471
                                             S
Space mean speed in ramp influence area,    S  = 56.8    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 56.8    mph
_______________________________________________________________________________
```

```
                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                     Fax:
E-mail:

________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         3/27/2008 10:03:18 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2015
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1490           vph

_________________________________On Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             40             vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1490        40                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                414         11                   v
Trucks and buses                       11          5                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.948       0.930
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1747        48                     pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1747   pc/h
                   12   F   FM

______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     1795          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1747          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   14.4    pc/mi/ln
                              R            12           A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation_________________________________

Intermediate speed variable,                M  = 0.288
                                             S
Space mean speed in ramp influence area,    S  = 61.9    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 61.9    mph
_______________________________________________________________________________
```

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Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 2:16:37 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Edgerton Road to Sunflower Road
Jurisdiction:	
Analysis Year:	2010
Description:	NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	1205	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	335	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	700	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	700	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	10.0	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

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E-mail:

_____Operational Analysis_____

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 2:16:37 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Sunflower Road to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	1570	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	436	v
Trucks and buses	12	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.943	
Driver population factor, fp	1.00	
Flow rate, vp	925	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	925	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	13.2	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2015 Wellsville North Alternative - AM Peak Hour - HCS Freeway Mainline

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_______________________Operational Analysis_______________________

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 2:16:37 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Gardner Road to US 56
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

_______________________Flow Inputs and Adjustments_______________________

Volume, V	2070	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	575	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1208	pc/h/ln

_______________________Speed Inputs and Adjustments_______________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______________________LOS and Performance Measures_______________________

Flow rate, vp	1208	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	17.3	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

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_______________________Operational Analysis_______________________

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 2:16:37 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	US 56 to 151st Street
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

_______________________Flow Inputs and Adjustments_______________________

Volume, V	3380	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	939	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1934	pc/h/ln

_______________________Speed Inputs and Adjustments_______________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______________________LOS and Performance Measures_______________________

Flow rate, vp	1934	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	66.0	mi/h
Number of lanes, N	2	
Density, D	29.3	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

2015 Wellsville North Alternative - AM Peak Hour - HCS Freeway Mainline

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_______________________Operational Analysis________________________________

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 2:16:37 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	151Street to US 56
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

_______________________Flow Inputs and Adjustments_________________________

Volume, V	1570	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	436	v
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.948	
Driver population factor, fp	1.00	
Flow rate, vp	920	pc/h/ln

_______________________Speed Inputs and Adjustments________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______________________LOS and Performance Measures________________________

Flow rate, vp	920	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	13.1	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

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_______________________Operational Analysis________________________________

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 2:16:37 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	US 56 to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

_______________________Flow Inputs and Adjustments_________________________

Volume, V	670	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	186	v
Trucks and buses	23	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.897	
Driver population factor, fp	1.00	
Flow rate, vp	415	pc/h/ln

_______________________Speed Inputs and Adjustments________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______________________LOS and Performance Measures________________________

Flow rate, vp	415	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	5.9	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

2015 Wellsville North Alternative - AM Peak Hour - HCS Freeway Mainline

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_____Operational Analysis_____

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 4/2/2008 2:16:37 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Southbound
From/To: Gardner Road to Sunflower Road
Jurisdiction: KDOT
Analysis Year: 2010
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	620	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	172	v
Trucks and buses	24	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.893	
Driver population factor, fp	1.00	
Flow rate, vp	386	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	386	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	5.5	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst: Trishul Palekar
Agency or Company: HDR Inc.
Date Performed: 4/2/2008 2:16:37 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Southbound
From/To: Sunflower Road to Edgerton Road
Jurisdiction:
Analysis Year: 2010
Description: NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	495	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	138	v
Trucks and buses	19	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.913	
Driver population factor, fp	1.00	
Flow rate, vp	301	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	301	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	4.3	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

2015 Wellsville North Alternative - PM Peak Hour - HCS Freeway Mainline

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Phone:                                      Fax:
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_________________________Operational Analysis__________________________________

Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         4/2/2008 2:16:37 PM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Northbound
From/To:                Edgerton Road to Sunflower Road
Jurisdiction:
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                   685           veh/h
Peak-hour factor, PHF                       0.90
Peak 15-min volume, v15                     190           v
Trucks and buses                            21            %
Recreational vehicles                       0             %
Terrain type:                               Level
    Grade                                   0.00          %
    Segment length                          0.00          mi
Trucks and buses PCE, ET                    1.5
Recreational vehicle PCE, ER                1.2
Heavy vehicle adjustment, fHV               0.905
Driver population factor, fp                1.00
Flow rate, vp                               421           pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                  12.0          ft
Right-shoulder lateral clearance            6.0           ft
Interchange density                         0.50          interchange/mi
Number of lanes, N                          2
Free-flow speed:                            Measured
     FFS or BFFS                            70.0          mi/h
Lane width adjustment, fLW                  0.0           mi/h
Lateral clearance adjustment, fLC           0.0           mi/h
Interchange density adjustment, fID         0.0           mi/h
Number of lanes adjustment, fN              0.0           mi/h
Free-flow speed, FFS                        70.0          mi/h
                                            Rural Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                               421           pc/h/ln
Free-flow speed, FFS                        70.0          mi/h
Average passenger-car speed, S              70.0          mi/h
Number of lanes, N                          2
Density, D                                  6.0           pc/mi/ln
Level of service, LOS                       A

  Overall results are not computed when free-flow speed is less than 55 mph.
```

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Phone:                                      Fax:
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_________________________Operational Analysis__________________________________

Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         4/2/2008 2:16:37 PM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Northbound
From/To:                Sunflower Road to Gardner Road
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                   850           veh/h
Peak-hour factor, PHF                       0.90
Peak 15-min volume, v15                     236           v
Trucks and buses                            25            %
Recreational vehicles                       0             %
Terrain type:                               Level
    Grade                                   0.00          %
    Segment length                          0.00          mi
Trucks and buses PCE, ET                    1.5
Recreational vehicle PCE, ER                1.2
Heavy vehicle adjustment, fHV               0.889
Driver population factor, fp                1.00
Flow rate, vp                               531           pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                  12.0          ft
Right-shoulder lateral clearance            6.0           ft
Interchange density                         0.50          interchange/mi
Number of lanes, N                          2
Free-flow speed:                            Measured
     FFS or BFFS                            70.0          mi/h
Lane width adjustment, fLW                  0.0           mi/h
Lateral clearance adjustment, fLC           0.0           mi/h
Interchange density adjustment, fID         0.0           mi/h
Number of lanes adjustment, fN              0.0           mi/h
Free-flow speed, FFS                        70.0          mi/h
                                            Rural Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                               531           pc/h/ln
Free-flow speed, FFS                        70.0          mi/h
Average passenger-car speed, S              70.0          mi/h
Number of lanes, N                          2
Density, D                                  7.6           pc/mi/ln
Level of service, LOS                       A

  Overall results are not computed when free-flow speed is less than 55 mph.
```

2015 Wellsville North Alternative - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_______Operational Analysis_______

```
Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         4/2/2008 2:16:37 PM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Northbound
From/To:                Gardner Road to US 56
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study
```

_______Flow Inputs and Adjustments_______

```
Volume, V                                1040          veh/h
Peak-hour factor, PHF                    0.90
Peak 15-min volume, v15                  289           v
Trucks and buses                         22            %
Recreational vehicles                    0             %
Terrain type:                            Level
    Grade                                0.00          %
    Segment length                       0.00          mi
Trucks and buses PCE, ET                 1.5
Recreational vehicle PCE, ER             1.2
Heavy vehicle adjustment, fHV            0.901
Driver population factor, fp             1.00
Flow rate, vp                            641           pc/h/ln
```

_______Speed Inputs and Adjustments_______

```
Lane width                               12.0          ft
Right-shoulder lateral clearance         6.0           ft
Interchange density                      0.50          interchange/mi
Number of lanes, N                       2
Free-flow speed:                         Measured
     FFS or BFFS                         70.0          mi/h
Lane width adjustment, fLW               0.0           mi/h
Lateral clearance adjustment, fLC        0.0           mi/h
Interchange density adjustment, fID      0.0           mi/h
Number of lanes adjustment, fN           0.0           mi/h
Free-flow speed, FFS                     70.0          mi/h
                                         Rural Freeway
```

_______LOS and Performance Measures_______

```
Flow rate, vp                            641           pc/h/ln
Free-flow speed, FFS                     70.0          mi/h
Average passenger-car speed, S           70.0          mi/h
Number of lanes, N                       2
Density, D                               9.2           pc/mi/ln
Level of service, LOS                    A
```

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_______Operational Analysis_______

```
Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         4/2/2008 2:16:37 PM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Northbound
From/To:                US 56 to 151st Street
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study
```

_______Flow Inputs and Adjustments_______

```
Volume, V                                1920          veh/h
Peak-hour factor, PHF                    0.90
Peak 15-min volume, v15                  533           v
Trucks and buses                         13            %
Recreational vehicles                    0             %
Terrain type:                            Level
    Grade                                0.00          %
    Segment length                       0.00          mi
Trucks and buses PCE, ET                 1.5
Recreational vehicle PCE, ER             1.2
Heavy vehicle adjustment, fHV            0.939
Driver population factor, fp             1.00
Flow rate, vp                            1136          pc/h/ln
```

_______Speed Inputs and Adjustments_______

```
Lane width                               12.0          ft
Right-shoulder lateral clearance         6.0           ft
Interchange density                      0.50          interchange/mi
Number of lanes, N                       2
Free-flow speed:                         Measured
     FFS or BFFS                         70.0          mi/h
Lane width adjustment, fLW               0.0           mi/h
Lateral clearance adjustment, fLC        0.0           mi/h
Interchange density adjustment, fID      0.0           mi/h
Number of lanes adjustment, fN           0.0           mi/h
Free-flow speed, FFS                     70.0          mi/h
                                         Rural Freeway
```

_______LOS and Performance Measures_______

```
Flow rate, vp                            1136          pc/h/ln
Free-flow speed, FFS                     70.0          mi/h
Average passenger-car speed, S           70.0          mi/h
Number of lanes, N                       2
Density, D                               16.2          pc/mi/ln
Level of service, LOS                    B
```

Overall results are not computed when free-flow speed is less than 55 mph.

2015 Wellsville North Alternative - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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Phone:                                    Fax:
E-mail:

_________________________Operational Analysis_________________________________

Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         4/2/2008 2:16:37 PM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Southbound
From/To:                151Street to US 56
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                 3180          veh/h
Peak-hour factor, PHF                     0.90
Peak 15-min volume, v15                   883           v
Trucks and buses                          9             %
Recreational vehicles                     0             %
Terrain type:                             Level
    Grade                                 0.00          %
    Segment length                        0.00          mi
Trucks and buses PCE, ET                  1.5
Recreational vehicle PCE, ER              1.2
Heavy vehicle adjustment, fHV             0.957
Driver population factor, fp              1.00
Flow rate, vp                             1846          pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                12.0          ft
Right-shoulder lateral clearance          6.0           ft
Interchange density                       0.50          interchange/mi
Number of lanes, N                        2
Free-flow speed:                          Measured
     FFS or BFFS                          70.0          mi/h
Lane width adjustment, fLW                0.0           mi/h
Lateral clearance adjustment, fLC         0.0           mi/h
Interchange density adjustment, fID       0.0           mi/h
Number of lanes adjustment, fN            0.0           mi/h
Free-flow speed, FFS                      70.0          mi/h
                                          Rural Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                             1846          pc/h/ln
Free-flow speed, FFS                      70.0          mi/h
Average passenger-car speed, S            67.3          mi/h
Number of lanes, N                        2
Density, D                                27.4          pc/mi/ln
Level of service, LOS                     D

  Overall results are not computed when free-flow speed is less than 55 mph.
```

HCS+: Basic Freeway Segments Release 5.21

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_________________________Operational Analysis_________________________________

Analyst:                Trishul Palekar
Agency or Company:      HDR Inc.
Date Performed:         4/2/2008 2:16:37 PM
Analysis Time Period:   PM
Freeway/Direction:      I-35 Southbound
From/To:                US 56 to Gardner Road
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                 2170          veh/h
Peak-hour factor, PHF                     0.90
Peak 15-min volume, v15                   603           v
Trucks and buses                          13            %
Recreational vehicles                     0             %
Terrain type:                             Level
    Grade                                 0.00          %
    Segment length                        0.00          mi
Trucks and buses PCE, ET                  1.5
Recreational vehicle PCE, ER              1.2
Heavy vehicle adjustment, fHV             0.939
Driver population factor, fp              1.00
Flow rate, vp                             1284          pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                12.0          ft
Right-shoulder lateral clearance          6.0           ft
Interchange density                       0.50          interchange/mi
Number of lanes, N                        2
Free-flow speed:                          Measured
     FFS or BFFS                          70.0          mi/h
Lane width adjustment, fLW                0.0           mi/h
Lateral clearance adjustment, fLC         0.0           mi/h
Interchange density adjustment, fID       0.0           mi/h
Number of lanes adjustment, fN            0.0           mi/h
Free-flow speed, FFS                      70.0          mi/h
                                          Rural Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                             1284          pc/h/ln
Free-flow speed, FFS                      70.0          mi/h
Average passenger-car speed, S            70.0          mi/h
Number of lanes, N                        2
Density, D                                18.3          pc/mi/ln
Level of service, LOS                     C

  Overall results are not computed when free-flow speed is less than 55 mph.
```

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Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 2:16:37 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	Gardner Road to Sunflower Road
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	1720	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	478	v
Trucks and buses	15	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.930	
Driver population factor, fp	1.00	
Flow rate, vp	1027	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	1027	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	14.7	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	Trishul Palekar
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 2:16:37 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	Sunflower Road to Edgerton Road
Jurisdiction:	
Analysis Year:	2010
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	1385	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	385	v
Trucks and buses	12	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.943	
Driver population factor, fp	1.00	
Flow rate, vp	816	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	816	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	11.7	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

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                  HCS+: Ramps and Ramp Junctions Release 5.21




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________________________________Diverge Analysis_______________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          4/2/2008 2:16:37 PM
Analysis time period:    AM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                1 Sunflower Exit
Jurisdiction:            KDOT
Analysis Year:           2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          1205          vph

________________________________Off Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0          mph
Volume on ramp                             25            vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

___________________Conversion to pc/h Under Base Conditions____________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1205        25                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                335         7                    v
Trucks and buses                       9           12                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.957       0.847
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1399        33                   pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1399   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks__________________________________

                          Actual        Maximum         LOS F?
     v  = v               1399          4800            No
      Fi   F
     v  = v - v           1366          4800            No
      FO   F   R
     v                    33            2000            No
      R
     v     v              0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?          No
      3 or  av34
Is   v     v      > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                          (Equation 25-18)
         12A

_____________________Flow Entering Diverge Influence Area______________________
                     Actual        Max Desirable          Violation?
     v               1399          4600                   No
      12                                                                   !
________________Level of Service Determination (if not F)______________________

Density,           D = 4.252 + 0.0086 v  - 0.009  L   =   9.1     pc/mi/ln
                                       R           12       D
Level of service for ramp-freeway junction areas of influence A

______________________________Speed Estimation_________________________________

Intermediate speed variable,                D  = 0.431
                                             S
Space mean speed in ramp influence area,    S  = 57.9    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.9    mph
_______________________________________________________________________________
```

```
                  HCS+: Ramps and Ramp Junctions Release 5.21




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________________________________Merge Analysis_________________________________

Analyst:                 Trishul Palekar
Agency/Co.:              HDR Inc.
Date performed:          4/2/2008 2:16:37 PM
Analysis time period:    AM
Freeway/Dir of Travel:   I-35 Northbound
Junction:                2 Sunflower Entr
Jurisdiction:            KDOT
Analysis Year:           2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          1180          vph

_________________________________On Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0          mph
Volume on ramp                             390           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

___________________Conversion to pc/h Under Base Conditions____________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1180        390                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                328         108                  v
Trucks and buses                       9           20                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.957       0.769
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1370        563                  pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1370   pc/h
                   12   F   FM

______________________________Capacity Checks__________________________________

                          Actual        Maximum         LOS F?
     v                    1933          4800            No
      FO
     v     v              0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?          No
      3 or  av34
Is   v     v      > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                          (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area______________________
                     Actual        Max Desirable          Violation?
     v               1370          4400                   No
      12                                                                   !
________________Level of Service Determination (if not F)______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   15.3    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation_________________________________

Intermediate speed variable,                M  = 0.292
                                             S
Space mean speed in ramp influence area,    S  = 61.8    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 61.8    mph
_______________________________________________________________________________
```

2015 Wellsville North Alternative - AM Peak Hour - HCS Freeway Ramps

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                        HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                     Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1570           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0           mph
Volume on ramp                             90             vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1570        90                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                436         25                   v
Trucks and buses                       12          2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.943       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1849        103                     pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1849   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1849          4800            No
      Fi   F
     v  = v - v            1746          4800            No
      FO   F   R
     v                     103           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v   =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1849          4600                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density,           D = 4.252 + 0.0086 v  - 0.009  L   =   13.0    pc/mi/ln
                                       R           12       D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.437
                                              S
Space mean speed in ramp influence area,     S  = 57.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.8    mph
________________________________________________________________________________
```

```
                        HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                     Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1480           vph

__________________________________On Ramp Data___________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             590            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1480        590                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                411         164                  v
Trucks and buses                       12          2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.943       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1743        675                     pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1743   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2418          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v   =                            (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1743          4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   19.0    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.309
                                              S
Space mean speed in ramp influence area,     S  = 61.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.4    mph
________________________________________________________________________________
```

2015 Wellsville North Alternative - AM Peak Hour - HCS Freeway Ramps

```
                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         2070          vph

________________________________Off Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            240           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2070        240                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 575         67                   v
Trucks and buses                        10          8                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.952       0.893
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2415        299                  pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2415   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                           Actual        Maximum        LOS F?
     v  = v                2415          4800           No
      Fi   F
     v  = v - v            2116          4800           No
      FO   F   R
     v                     299           2000           No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual       Max Desirable        Violation?
     v                2415         4600                 No
      12                                                                   !
_________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L  =   17.8    pc/mi/ln
                        R                 12         D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation_________________________________

Intermediate speed variable,               D  = 0.455
                                            S
Space mean speed in ramp influence area,   S  = 57.3    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 57.3    mph
_______________________________________________________________________________
```

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                     HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
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________________________________Merge Analysis_________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         3250          vph

_________________________________On Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            130           vph
Length of first accel/decel lane          1000          ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         3250        130                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 903         36                   v
Trucks and buses                        10          2                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
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Heavy vehicle adjustment, fHV           0.952       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3792        149                  pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  3792   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum        LOS F?
     v                     3941          4800           No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual       Max Desirable        Violation?
     v                3792         4400                 No
      12                                                                   !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L  =   29.9    pc/mi/ln
                              R            12           A
Level of service for ramp-freeway junction areas of influence  D

______________________________Speed Estimation_________________________________

Intermediate speed variable,               M  = 0.452
                                            S
Space mean speed in ramp influence area,   S  = 57.4    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 57.4    mph
_______________________________________________________________________________
```

2015 Wellsville North Alternative - AM Peak Hour - HCS Freeway Ramps

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________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                        Merge
Number of lanes in freeway              2
Free-flow speed on freeway              70.0            mph
Volume on freeway                       1830            vph

_________________________________On Ramp Data_________________________________

Side of freeway                         Right
Number of lanes in ramp                 1
Free-flow speed on ramp                 35.0            mph
Volume on ramp                          1420            vph
Length of first accel/decel lane        500             ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?               No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

___________________Conversion to pc/h Under Base Conditions__________________

Junction Components                 Freeway    Ramp       Adjacent
                                                          Ramp
Volume, V (vph)                     1830       1420                vph
Peak-hour factor, PHF               0.90       0.90
Peak 15-min volume, v15             508        394                 v
Trucks and buses                    10         2                   %
Recreational vehicles               0          0                   %
Terrain type:                       Level      Rolling
    Grade                                 %          %          %
    Length                                mi         mi         mi
Trucks and buses PCE, ET            1.5*       2.5
Recreational vehicle PCE, ER        1.2*       2.0

Heavy vehicle adjustment, fHV         0.952      0.971
Driver population factor, fP          1.00       1.00
Flow rate, vp                         2135       1625                   pcph

_________________________Estimation of V12 Merge Areas_______________________

               L  =           (Equation 25-2 or 25-3)
                EQ
               P  =    1.000   Using Equation  0
                FM
               v  = v  (P  ) =  2135   pc/h
                12   F   FM

_______________________________Capacity Checks________________________________

                         Actual       Maximum        LOS F?
    v                    3760         4800           No
     FO
    v     v              0    pc/h    (Equation 25-4 or 25-5)
     3 or  av34
Is   v     v      > 2700 pc/h?        No
     3 or  av34
Is   v     v      > 1.5 v  /2         No
     3 or  av34          12
If yes, v    =                        (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area____________________
                    Actual       Max Desirable        Violation?
    v               2135         4400                 No
     12                                                                    !
________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   30.9    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  D

____________________________Speed Estimation__________________________________

Intermediate speed variable,            M  = 0.453
                                         S
Space mean speed in ramp influence area,  S  = 57.3    mph
                                         R
Space mean speed in outer lanes,        S  =  N/A    mph
                                         0
Space mean speed for all vehicles,      S  = 57.3    mph
______________________________________________________________________________
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_______________________________Diverge Analysis_______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               8 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                        Diverge
Number of lanes in freeway              2
Free-flow speed on freeway              70.0            mph
Volume on freeway                       1570            vph

________________________________Off Ramp Data_________________________________

Side of freeway                         Right
Number of lanes in ramp                 1
Free-Flow speed on ramp                 45.0            mph
Volume on ramp                          970             vph
Length of first accel/decel lane        800             ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?               No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

___________________Conversion to pc/h Under Base Conditions__________________

Junction Components                 Freeway    Ramp       Adjacent
                                                          Ramp
Volume, V (vph)                     1570       970                 vph
Peak-hour factor, PHF               0.90       0.90
Peak 15-min volume, v15             436        269                 v
Trucks and buses                    11         3                   %
Recreational vehicles               0          0                   %
Terrain type:                       Level      Rolling
    Grade                           0.00    %  0.00    %          %
    Length                          0.00   mi  0.00   mi         mi
Trucks and buses PCE, ET            1.5*       2.5
Recreational vehicle PCE, ER        1.2*       2.0

Heavy vehicle adjustment, fHV         0.948      0.957
Driver population factor, fP          1.00       1.00
Flow rate, vp                         1840       1126                   pcph

_________________________Estimation of V12 Diverge Areas_____________________

               L  =           (Equation 25-8 or 25-9)
                EQ
               P  =    1.000   Using Equation  0
                FD
               v  = v  + (v - v ) P  =  1840   pc/h
                12   R     F   R   FD

_______________________________Capacity Checks________________________________

                         Actual       Maximum        LOS F?
    v  = v               1840         4800           No
     Fi   F
    v  = v - v           714          4800           No
     FO   F   R
    v                    1126         2100           No
     R
    v     v              0    pc/h    (Equation 25-15 or 25-16)
     3 or  av34
Is   v     v      > 2700 pc/h?        No
     3 or  av34
Is   v     v      > 1.5 v  /2         No
     3 or  av34          12
If yes, v    =                        (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area__________________
                    Actual       Max Desirable        Violation?
    v               1840         4600                 No
     12                                                                    !
________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   12.9    pc/mi/ln
                                          R           12          D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation__________________________________

Intermediate speed variable,            D  = 0.399
                                         S
Space mean speed in ramp influence area,  S  = 58.8    mph
                                         R
Space mean speed in outer lanes,        S  =  N/A    mph
                                         0
Space mean speed for all vehicles,      S  = 58.8    mph
______________________________________________________________________________
```

2015 Wellsville North Alternative - AM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
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________________________________Merge Analysis__________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               9 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         600           vph

_________________________________On Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            70            vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        600         70                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                167         19                   v
Trucks and buses                       11          17                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.948       0.797
Driver population factor, fP           1.00        1.00
Flow rate, vp                          703         98                   pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  703    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     801           4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34             12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                703           4400                  No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   6.7     pc/mi/ln
          R                   R            12             A
Level of service for ramp-freeway junction areas of influence  A

______________________________Speed Estimation_________________________________

Intermediate speed variable,                 M  = 0.274
                                              S
Space mean speed in ramp influence area,     S  = 62.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.3    mph
_______________________________________________________________________________
```

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________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         670           vph

________________________________Off Ramp Data__________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            100           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        670         100                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                186         28                   v
Trucks and buses                       23          13                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00   %    0.00   %           %
     Length                            0.00   mi   0.00   mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.897       0.837
Driver population factor, fP           1.00        1.00
Flow rate, vp                          830         133                  pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  830    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                830           4800            No
      Fi   F
     v  = v - v            697           4800            No
      FO   F   R
     v                     133           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34             12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                830           4600                  No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   4.2     pc/mi/ln
                                          R            12          D
Level of service for ramp-freeway junction areas of influence A

______________________________Speed Estimation_________________________________

Intermediate speed variable,                 D  = 0.440
                                              S
Space mean speed in ramp influence area,     S  = 57.7    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.7    mph
_______________________________________________________________________________
```

2015 Wellsville North Alternative - AM Peak Hour - HCS Freeway Ramps

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                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
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________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                         Merge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0          mph
Volume on freeway                        570           vph

_________________________________On Ramp Data_________________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-flow speed on ramp                  35.0          mph
Volume on ramp                           50            vph
Length of first accel/decel lane         800           ft
Length of second accel/decel lane                      ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                No
Volume on adjacent Ramp                                vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                              ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                  Freeway     Ramp        Adjacent
                                                             Ramp
Volume, V (vph)                      570         50                   vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              158         14                   v
Trucks and buses                     23          4                    %
Recreational vehicles                0           0                    %
Terrain type:                        Level       Rolling
     Grade                                   %           %            %
     Length                                  mi          mi           mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
Heavy vehicle adjustment, fHV        0.897       0.943
Driver population factor, fP         1.00        1.00
Flow rate, vp                        706         59                   pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  706    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum        LOS F?
     v                     765           4800           No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v         > 2700 pc/h?        No
      3 or  av34
Is   v     v         > 1.5 v  /2         No
      3 or  av34            12
If yes, v    =                           (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable        Violation?
     v                706           4400                 No
      12                                                                    !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   6.4     pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  A

____________________________Speed Estimation__________________________________

Intermediate speed variable,              M  = 0.273
                                           S
Space mean speed in ramp influence area,  S  = 62.3    mph
                                           R
Space mean speed in outer lanes,          S  =  N/A    mph
                                           0
Space mean speed for all vehicles,        S  = 62.3    mph
_______________________________________________________________________________
```

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________________________________Diverge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                         Diverge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0          mph
Volume on freeway                        620           vph

________________________________Off Ramp Data_________________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-Flow speed on ramp                  35.0          mph
Volume on ramp                           140           vph
Length of first accel/decel lane         800           ft
Length of second accel/decel lane                      ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                No
Volume on adjacent ramp                                vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                              ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                  Freeway     Ramp        Adjacent
                                                             Ramp
Volume, V (vph)                      620         140                  vph
Peak-hour factor, PHF                0.90        0.90
Peak 15-min volume, v15              172         39                   v
Trucks and buses                     24          0                    %
Recreational vehicles                0           0                    %
Terrain type:                        Level       Rolling
     Grade                           0.00    %   0.00    %            %
     Length                          0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET             1.5*        2.5
Recreational vehicle PCE, ER         1.2*        2.0
Heavy vehicle adjustment, fHV        0.893       1.000
Driver population factor, fP         1.00        1.00
Flow rate, vp                        772         156                  pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  772    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum        LOS F?
     v  = v                772           4800           No
      Fi   F
     v  = v - v            616           4800           No
      FO   F   R
     v                     156           2000           No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v         > 2700 pc/h?        No
      3 or  av34
Is   v     v         > 1.5 v  /2         No
      3 or  av34            12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable        Violation?
     v                772           4600                 No
      12                                                                    !
________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   3.7     pc/mi/ln
                       R                 12           D
Level of service for ramp-freeway junction areas of influence A

____________________________Speed Estimation__________________________________

Intermediate speed variable,              D  = 0.442
                                           S
Space mean speed in ramp influence area,  S  = 57.6    mph
                                           R
Space mean speed in outer lanes,          S  =  N/A    mph
                                           0
Space mean speed for all vehicles,        S  = 57.6    mph
_______________________________________________________________________________
```

2015 Wellsville North Alternative - AM Peak Hour - HCS Freeway Ramps

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              HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
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________________________________Merge Analysis_______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           480           vph

_________________________________On Ramp Data________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              15            vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp       Adjacent
                                                              Ramp
Volume, V (vph)                        480         15                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                133         4                    v
Trucks and buses                       24          13                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.893       0.837
Driver population factor, fP           1.00        1.00
Flow rate, vp                          597         20                      pcph

________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  597    pc/h
                   12   F   FM

______________________________Capacity Checks__________________________________

                             Actual        Maximum         LOS F?
     v                       617           4800            No
      FO
     v     v                 0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?            No
      3 or  av34
Is   v     v       > 1.5 v  /2             No
      3 or  av34         12
If yes, v    =                             (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area____________________
                        Actual        Max Desirable         Violation?
     v                  597           4400                  No
      12                                                                      !
_________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   5.3     pc/mi/ln
          R                  R           12           A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                  M  = 0.272
                                               S
Space mean speed in ramp influence area,      S  = 62.4    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 62.4    mph
_______________________________________________________________________________
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2015 Wellsville North Alternative - PM Peak Hour - HCS Freeway Ramps

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                         HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
E-mail:

_________________________________Diverge Analysis_______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           685           vph

_________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              15            vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)______________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        685         15                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                190         4                    v
Trucks and buses                       21          20                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.905       0.769
Driver population factor, fP           1.00        1.00
Flow rate, vp                          841         22                   pcph

_________________________Estimation of V12 Diverge Areas________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  841    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                841           4800            No
      Fi   F
     v  = v - v            819           4800            No
      FO   F   R
     v                     22            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                841           4600                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density,            D = 4.252 + 0.0086 v  - 0.009  L   =   4.3     pc/mi/ln
                     R                   12        D
Level of service for ramp-freeway junction areas of influence A

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.430
                                              S
Space mean speed in ramp influence area,     S  = 58.0    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 58.0    mph
________________________________________________________________________________
```

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                         HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
E-mail:

_________________________________Merge Analysis_________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           670           vph

__________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              180           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)______________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        670         180                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                186         50                   v
Trucks and buses                       21          0                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.905       1.000
Driver population factor, fP           1.00        1.00
Flow rate, vp                          823         200                  pcph

_________________________Estimation of V12 Merge Areas__________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  823    pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     1023          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                823           4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   8.3     pc/mi/ln
          R                   R             12            A
Level of service for ramp-freeway junction areas of influence  A

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.276
                                              S
Space mean speed in ramp influence area,     S  = 62.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.3    mph
________________________________________________________________________________
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Phone:                                      Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data____________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           850            vph

_________________________________Off Ramp Data____________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              60             vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        850         60                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                236         17                   v
Trucks and buses                       25          7                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.889       0.905
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1063        74                      pcph

_________________________Estimation of V12 Diverge Areas________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1063   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                1063          4800            No
      Fi   F
     v  = v - v            989           4800            No
      FO   F   R
     v                     74            2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1063          4600                   No
      12                                                                        !
_________________Level of Service Determination (if not F)____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L  =    6.2     pc/mi/ln
                                         R             12         D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                 D  = 0.435
                                              S
Space mean speed in ramp influence area,     S  = 57.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.8    mph
_______________________________________________________________________________
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Phone:                                      Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data____________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           790            vph

__________________________________On Ramp Data____________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              250            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        790         250                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                219         69                   v
Trucks and buses                       25          6                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.889       0.917
Driver population factor, fP           1.00        1.00
Flow rate, vp                          988         303                     pcph

_________________________Estimation of V12 Merge Areas__________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  988    pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     1291          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                988           4400                   No
      12                                                                        !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L  =   10.4    pc/mi/ln
                              R            12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                 M  = 0.279
                                              S
Space mean speed in ramp influence area,     S  = 62.2    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.2    mph
_______________________________________________________________________________
```

2015 Wellsville North Alternative - PM Peak Hour - HCS Freeway Ramps

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                HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
E-mail:

_________________________________Diverge Analysis_______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1040           vph

_________________________________Off Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0           mph
Volume on ramp                             120            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp       Adjacent
                                                              Ramp
Volume, V (vph)                        1040        120                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                289         33                  v
Trucks and buses                       22          11                  %
Recreational vehicles                  0           0                   %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %           %
     Length                            0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.901       0.858
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1283        155                    pcph

_________________________Estimation of V12 Diverge Areas________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1283   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                            Actual        Maximum         LOS F?
     v  = v                 1283          4800            No
      Fi   F
     v  = v - v             1128          4800            No
      FO   F   R
     v                      155           2000            No
      R
     v     v                0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?            No
      3 or  av34
Is   v     v      > 1.5 v  /2             No
      3 or  av34         12
If yes, v    =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                       Actual        Max Desirable          Violation?
     v                 1283          4600                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density,            D = 4.252 + 0.0086 v  - 0.009  L   =   8.1     pc/mi/ln
                     R                  12          D
Level of service for ramp-freeway junction areas of influence A

________________________________Speed Estimation________________________________

Intermediate speed variable,                 D  = 0.442
                                              S
Space mean speed in ramp influence area,     S  = 57.6    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.6    mph
________________________________________________________________________________
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                HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
E-mail:

_________________________________Merge Analysis_________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1900           vph

__________________________________On Ramp Data__________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             20             vph
Length of first accel/decel lane           1000           ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp       Adjacent
                                                              Ramp
Volume, V (vph)                        1900        20                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                528         6                   v
Trucks and buses                       22          3                   %
Recreational vehicles                  0           0                   %
Terrain type:                          Level       Rolling
     Grade                                     %           %           %
     Length                                    mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.901       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2343        23                     pcph

_________________________Estimation of V12 Merge Areas__________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2343   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                            Actual        Maximum         LOS F?
     v                      2366          4800            No
      FO
     v     v                0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?            No
      3 or  av34
Is   v     v      > 1.5 v  /2             No
      3 or  av34         12
If yes, v    =                            (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area______________________
                       Actual        Max Desirable          Violation?
     v                 2343          4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   17.6    pc/mi/ln
          R                   R          12             A
Level of service for ramp-freeway junction areas of influence  B

________________________________Speed Estimation________________________________

Intermediate speed variable,                 M  = 0.293
                                              S
Space mean speed in ramp influence area,     S  = 61.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.8    mph
________________________________________________________________________________
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2015 Wellsville North Alternative - PM Peak Hour - HCS Freeway Ramps

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                HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                               Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:               Trishul Palekar
Agency/Co.:            HDR Inc.
Date performed:        4/2/2008 2:16:37 PM
Analysis time period:  PM
Freeway/Dir of Travel: I-35 Northbound
Junction:              7 Loop Ramp Entr
Jurisdiction:          KDOT
Analysis Year:         2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Merge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         920           vph

_________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            980           vph
Length of first accel/decel lane          500           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

___________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        920         980                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                256         272                  v
Trucks and buses                       22          3                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
    Grade                                     %           %           %
    Length                                    mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.901       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1135        1138                 pcph

________________________Estimation of V12 Merge Areas_________________________

                 L  =            (Equation 25-2 or 25-3)
                  EQ
                 P  =    1.000   Using Equation  0
                  FM
                 v  = v  (P  ) =  1135   pc/h
                  12   F   FM

______________________________Capacity Checks_________________________________

                          Actual        Maximum         LOS F?
     v                    2273          4800            No
      FO
     v     v              0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?        No
      3 or  av34
Is   v     v        > 1.5 v  /2         No
      3 or  av34           12
If yes, v    =                          (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area____________________
                     Actual        Max Desirable          Violation?
     v               1135          4400                   No
      12                                                                  !
________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   19.5    pc/mi/ln
          R                  R          12             A
Level of service for ramp-freeway junction areas of influence  B

____________________________Speed Estimation_________________________________

Intermediate speed variable,              M  = 0.324
                                           S
Space mean speed in ramp influence area,  S  = 60.9    mph
                                           R
Space mean speed in outer lanes,          S  =  N/A    mph
                                           0
Space mean speed for all vehicles,        S  = 60.9    mph
_____________________________________________________________________________
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                HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                               Fax:
E-mail:

_______________________________Diverge Analysis_______________________________

Analyst:               Trishul Palekar
Agency/Co.:            HDR Inc.
Date performed:        4/2/2008 2:16:37 PM
Analysis time period:  PM
Freeway/Dir of Travel: I-35 Southbound
Junction:              8 US 56 Exit
Jurisdiction:          KDOT
Analysis Year:         2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Diverge
Number of lanes in freeway                2
Free-flow speed on freeway                70.0          mph
Volume on freeway                         3180          vph

________________________________Off Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   45.0          mph
Volume on ramp                            1320          vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

___________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        3180        1320                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                883         367                  v
Trucks and buses                       9           2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
    Grade                              0.00   %    0.00   %           %
    Length                             0.00   mi   0.00   mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.957       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3692        1511                 pcph

________________________Estimation of V12 Diverge Areas_______________________

                 L  =            (Equation 25-8 or 25-9)
                  EQ
                 P  =    1.000   Using Equation  0
                  FD
                 v  = v  + (v - v ) P  =  3692   pc/h
                  12   R     F   R   FD

______________________________Capacity Checks_________________________________

                          Actual        Maximum         LOS F?
     v  = v               3692          4800            No
      Fi   F
     v  = v - v           2181          4800            No
      FO   F   R
     v                    1511          2100            No
      R
     v     v              0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?        No
      3 or  av34
Is   v     v        > 1.5 v  /2         No
      3 or  av34           12
If yes, v    =                          (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area__________________
                     Actual        Max Desirable          Violation?
     v               3692          4600                   No
      12                                                                  !
________________Level of Service Determination (if not F)___________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   28.8    pc/mi/ln
                                          R          12          D
Level of service for ramp-freeway junction areas of influence D

____________________________Speed Estimation_________________________________

Intermediate speed variable,              D  = 0.434
                                           S
Space mean speed in ramp influence area,  S  = 57.8    mph
                                           R
Space mean speed in outer lanes,          S  =  N/A    mph
                                           0
Space mean speed for all vehicles,        S  = 57.8    mph
_____________________________________________________________________________
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                HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                  Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               9 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          1860          vph

_________________________________On Ramp Data_________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0          mph
Volume on ramp                             310           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1860        310                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                517         86                   v
Trucks and buses                       9           4                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.957       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2160        365                  pcph

________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2160   pc/h
                   12   F   FM

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2525          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                2160          4400                   No
      12                                                                  !
________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   20.0-   pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.314
                                              S
Space mean speed in ramp influence area,     S  = 61.2    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.2    mph
______________________________________________________________________________
```

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                HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                  Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Trishul Palekar
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 2:16:37 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2010
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          2170          vph

________________________________Off Ramp Data_________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0          mph
Volume on ramp                             540           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        2170        540                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                603         150                  v
Trucks and buses                       13          4                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.939       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2568        636                  pcph

________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2568   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                2568          4800            No
      Fi   F
     v  = v - v            1932          4800            No
      FO   F   R
     v                     636           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                2568          4600                   No
      12                                                                  !
________________Level of Service Determination (if not F)____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   19.1    pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.485
                                              S
Space mean speed in ramp influence area,     S  = 56.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 56.4    mph
______________________________________________________________________________
```

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Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Trishul Palekar
Agency/Co.:	HDR Inc.
Date performed:	4/2/2008 2:16:37 PM
Analysis time period:	PM
Freeway/Dir of Travel:	I-35 Southbound
Junction:	11 Gardner Entr
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1630	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	90	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	1630		90			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	453		25			v
Trucks and buses	13		6			%
Recreational vehicles	0		0			%
Terrain type:	Level		Rolling			
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5*		2.5			
Recreational vehicle PCE, ER	1.2*		2.0			
Heavy vehicle adjustment, fHV	0.939		0.917			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	1929		109			pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1929 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2038	4800	No
v_{3} or v_{av34}	0 pc/h	(Equation 25-4 or 25-5)	
Is v_{3} or v_{av34} > 2700 pc/h?		No	
Is v_{3} or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} =		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1929	4400	No

!

Level of Service Determination (if not F)

Density, $D = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 16.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.295
Space mean speed in ramp influence area,	S_R = 61.7 mph
Space mean speed in outer lanes,	S_0 = N/A mph
Space mean speed for all vehicles,	S = 61.7 mph

HCS+: Ramps and Ramp Junctions Release 5.21

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Trishul Palekar
Agency/Co.:	HDR Inc.
Date performed:	4/2/2008 2:16:37 PM
Analysis time period:	PM
Freeway/Dir of Travel:	I-35 Southbound
Junction:	12 Sunflower Exit
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1720	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	370	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	1720		370			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	478		103			v
Trucks and buses	15		25			%
Recreational vehicles	0		0			%
Terrain type:	Level		Rolling			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5*		2.5			
Recreational vehicle PCE, ER	1.2*		2.0			
Heavy vehicle adjustment, fHV	0.930		0.727			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	2054		565			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2054 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	2054	4800	No
$v_{FO} = v_F - v_R$	1489	4800	No
v_R	565	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} =		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2054	4600	No

!

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 14.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	D_S = 0.479
Space mean speed in ramp influence area,	S_R = 56.6 mph
Space mean speed in outer lanes,	S_0 = N/A mph
Space mean speed for all vehicles,	S = 56.6 mph

2015 Wellsville North Alternative - PM Peak Hour - HCS Freeway Ramps

HCS+: Ramps and Ramp Junctions Release 5.21

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Trishul Palekar
Agency/Co.:	HDR Inc.
Date performed:	4/2/2008 2:16:37 PM
Analysis time period:	PM
Freeway/Dir of Travel:	I-35 Southbound
Junction:	13 Sunflower Entr
Jurisdiction:	KDOT
Analysis Year:	2010
Description:	NEPA Traffic Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1350	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	35	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1350	35		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	375	10		v
Trucks and buses	15	11		%
Recreational vehicles	0	0		%
Terrain type:	Level	Rolling		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5*	2.5		
Recreational vehicle PCE, ER	1.2*	2.0		
Heavy vehicle adjustment, fHV	0.930	0.858		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	1612	45		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1612 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1657	4800	No
v_{3} or v_{av34}	0 pc/h	(Equation 25-4 or 25-5)	
Is v_{3} or v_{av34} > 2700 pc/h?		No	
Is v_{3} or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} =		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1612	4400	No

!

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 13.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.285
Space mean speed in ramp influence area,	S_R = 62.0 mph
Space mean speed in outer lanes,	S_0 = N/A mph
Space mean speed for all vehicles,	S = 62.0 mph

2030 Wellsville North No Action - AM Peak Hour - HCS Freeway Mainline

```
                    HCS+: Basic Freeway Segments Release 5.21

Phone:                                  Fax:
E-mail:

________________________Operational Analysis_________________________________

Analyst:                Tom Hiles
Agency or Company:      HDR Inc.
Date Performed:         4/1/2008 4:10:06 PM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Northbound
From/To:                Edgerton Road to Sunflower Road
Jurisdiction:
Analysis Year:          2030
Description:  NEPA Traffic Study

________________________Flow Inputs and Adjustments__________________________

Volume, V                               2400          veh/h
Peak-hour factor, PHF                   0.90
Peak 15-min volume, v15                 667           v
Trucks and buses                        9             %
Recreational vehicles                   0             %
Terrain type:                           Level
    Grade                               0.00          %
    Segment length                      0.00          mi
Trucks and buses PCE, ET                1.5
Recreational vehicle PCE, ER            1.2
Heavy vehicle adjustment, fHV           0.957
Driver population factor, fp            1.00
Flow rate, vp                           1393          pc/h/ln

________________________Speed Inputs and Adjustments_________________________

Lane width                              12.0          ft
Right-shoulder lateral clearance        6.0           ft
Interchange density                     0.50          interchange/mi
Number of lanes, N                      2
Free-flow speed:                        Measured
     FFS or BFFS                        70.0          mi/h
Lane width adjustment, fLW              0.0           mi/h
Lateral clearance adjustment, fLC       0.0           mi/h
Interchange density adjustment, fID     0.0           mi/h
Number of lanes adjustment, fN          0.0           mi/h
Free-flow speed, FFS                    70.0          mi/h
                                        Rural Freeway

________________________LOS and Performance Measures_________________________

Flow rate, vp                           1393          pc/h/ln
Free-flow speed, FFS                    70.0          mi/h
Average passenger-car speed, S          70.0          mi/h
Number of lanes, N                      2
Density, D                              19.9          pc/mi/ln
Level of service, LOS                   C

  Overall results are not computed when free-flow speed is less than 55 mph.
```

```
                    HCS+: Basic Freeway Segments Release 5.21

Phone:                                  Fax:
E-mail:

________________________Operational Analysis_________________________________

Analyst:                Tom Hiles
Agency or Company:      HDR Inc.
Date Performed:         4/1/2008 4:10:06 PM
Analysis Time Period:   AM
Freeway/Direction:      I-35 Northbound
From/To:                Gardner Road to US 56
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

________________________Flow Inputs and Adjustments__________________________

Volume, V                               4360          veh/h
Peak-hour factor, PHF                   0.90
Peak 15-min volume, v15                 1211          v
Trucks and buses                        6             %
Recreational vehicles                   0             %
Terrain type:                           Level
    Grade                               0.00          %
    Segment length                      0.00          mi
Trucks and buses PCE, ET                1.5
Recreational vehicle PCE, ER            1.2
Heavy vehicle adjustment, fHV           0.971
Driver population factor, fp            1.00
Flow rate, vp                           1663          pc/h/ln

________________________Speed Inputs and Adjustments_________________________

Lane width                              12.0          ft
Right-shoulder lateral clearance        6.0           ft
Interchange density                     0.50          interchange/mi
Number of lanes, N                      3
Free-flow speed:                        Measured
     FFS or BFFS                        70.0          mi/h
Lane width adjustment, fLW              0.0           mi/h
Lateral clearance adjustment, fLC       0.0           mi/h
Interchange density adjustment, fID     0.0           mi/h
Number of lanes adjustment, fN          3.0           mi/h
Free-flow speed, FFS                    70.0          mi/h
                                        Urban Freeway

________________________LOS and Performance Measures_________________________

Flow rate, vp                           1663          pc/h/ln
Free-flow speed, FFS                    70.0          mi/h
Average passenger-car speed, S          69.1          mi/h
Number of lanes, N                      3
Density, D                              24.1          pc/mi/ln
Level of service, LOS                   C

  Overall results are not computed when free-flow speed is less than 55 mph.
```

2030 Wellsville North No Action - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

___Operational Analysis___

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:10:06 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Sunflower Road to Waverly Road
Jurisdiction:	KDOT
Analysis Year:	2030

Description: NEPA Traffic Study

___Flow Inputs and Adjustments___

Volume, V	2920	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	811	v
Trucks and buses	8	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.962	
Driver population factor, fp	1.00	
Flow rate, vp	1687	pc/h/ln

___Speed Inputs and Adjustments___

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

___LOS and Performance Measures___

Flow rate, vp	1687	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	68.9	mi/h
Number of lanes, N	2	
Density, D	24.5	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

___Operational Analysis___

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:10:06 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	US 56 to 151st Street
Jurisdiction:	KDOT
Analysis Year:	2030

Description: NEPA Traffic Study

___Flow Inputs and Adjustments___

Volume, V	5690	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1581	v
Trucks and buses	5	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.976	
Driver population factor, fp	1.00	
Flow rate, vp	2160	pc/h/ln

___Speed Inputs and Adjustments___

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

___LOS and Performance Measures___

Flow rate, vp	2160	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	61.2	mi/h
Number of lanes, N	3	
Density, D	35.3	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Wellsville North No Action - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_______Operational Analysis_______

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:10:06 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: Waverly Road to Gardner Road
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

_______Flow Inputs and Adjustments_______

Volume, V	3260	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	906	v
Trucks and buses	7	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.966	
Driver population factor, fp	1.00	
Flow rate, vp	1250	pc/h/ln

_______Speed Inputs and Adjustments_______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	1.15	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	3.2	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______LOS and Performance Measures_______

Flow rate, vp	1250	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	17.9	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_______Operational Analysis_______

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:10:06 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Southbound
From/To: 151Street to US 56
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

_______Flow Inputs and Adjustments_______

Volume, V	3480	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	967	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1347	pc/h/ln

_______Speed Inputs and Adjustments_______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_______LOS and Performance Measures_______

Flow rate, vp	1347	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	19.2	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Wellsville North No Action - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Level of service, LOS A

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: Fax:
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_________________________Operational Analysis__________________________________

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:10:06 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Southbound
From/To: Gardner Road to Waverly Road
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V	1630	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	453	v
Trucks and buses	15	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.930	
Driver population factor, fp	1.00	
Flow rate, vp	649	pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	1.15	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	3.2	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_________________________LOS and Performance Measures__________________________

Flow rate, vp	649	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	9.3	pc/mi/ln

HCS+: Basic Freeway Segments Release 5.21

Level of service, LOS A

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: Fax:
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_________________________Operational Analysis__________________________________

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/1/2008 4:10:06 PM
Analysis Time Period: AM
Freeway/Direction: I-35 Southbound
From/To: Sunflower Road to Edgerton Road
Jurisdiction:
Analysis Year: 2030
Description: NEPA Traffic Study

_________________________Flow Inputs and Adjustments___________________________

Volume, V	1190	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	331	v
Trucks and buses	20	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.909	
Driver population factor, fp	1.00	
Flow rate, vp	727	pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_________________________LOS and Performance Measures__________________________

Flow rate, vp	727	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	10.4	pc/mi/ln

2030 Wellsville North No Action - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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_________Operational Analysis_________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:10:06 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	US 56 to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

_________Flow Inputs and Adjustments_________

Volume, V	2280	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	633	v
Trucks and buses	13	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.939	
Driver population factor, fp	1.00	
Flow rate, vp	899	pc/h/ln

_________Speed Inputs and Adjustments_________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_________LOS and Performance Measures_________

Flow rate, vp	899	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	12.8	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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_________Operational Analysis_________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:10:06 PM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	Waverly Road to Sunflower Road
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

_________Flow Inputs and Adjustments_________

Volume, V	1270	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	353	v
Trucks and buses	19	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.913	
Driver population factor, fp	1.00	
Flow rate, vp	773	pc/h/ln

_________Speed Inputs and Adjustments_________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_________LOS and Performance Measures_________

Flow rate, vp	773	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	11.0+	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:10:06 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Edgerton Road to Sunflower Road
Jurisdiction:	
Analysis Year:	2030
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	1350	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	375	v
Trucks and buses	21	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.905	
Driver population factor, fp	1.00	
Flow rate, vp	829	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	829	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	11.8	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:10:06 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Sunflower Road to Waverly Road
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	1540	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	428	v
Trucks and buses	19	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.913	
Driver population factor, fp	1.00	
Flow rate, vp	937	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

LOS and Performance Measures

Flow rate, vp	937	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	13.4	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Wellsville North No Action - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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______________________Operational Analysis______________________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:10:06 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Waverly Road to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

______________________Flow Inputs and Adjustments______________________

Volume, V	1960	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	544	v
Trucks and buses	16	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.926	
Driver population factor, fp	1.00	
Flow rate, vp	784	pc/h/ln

______________________Speed Inputs and Adjustments______________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	1.15	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	3.2	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

______________________LOS and Performance Measures______________________

Flow rate, vp	784	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	11.2	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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E-mail:

______________________Operational Analysis______________________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:10:06 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Gardner Road to US 56
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

______________________Flow Inputs and Adjustments______________________

Volume, V	2760	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	767	v
Trucks and buses	12	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.943	
Driver population factor, fp	1.00	
Flow rate, vp	1084	pc/h/ln

______________________Speed Inputs and Adjustments______________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

______________________LOS and Performance Measures______________________

Flow rate, vp	1084	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	15.5	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Wellsville North No Action - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
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_______________________Operational Analysis________________________________

Analyst:	Tom Hiles	
Agency or Company:	HDR Inc.	
Date Performed:	4/1/2008 4:10:06 PM	
Analysis Time Period:	PM	
Freeway/Direction:	I-35 Northbound	
From/To:	US 56 to 151st Street	
Jurisdiction:	KDOT	
Analysis Year:	2030	
Description: NEPA Traffic Study		

_______________________Flow Inputs and Adjustments__________________________

Volume, V	4200	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1167	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1626	pc/h/ln

_______________________Speed Inputs and Adjustments_________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_______________________LOS and Performance Measures_________________________

Flow rate, vp	1626	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	69.3	mi/h
Number of lanes, N	3	
Density, D	23.5	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_______________________Operational Analysis________________________________

Analyst:	Tom Hiles	
Agency or Company:	HDR Inc.	
Date Performed:	4/1/2008 4:10:06 PM	
Analysis Time Period:	PM	
Freeway/Direction:	I-35 Southbound	
From/To:	151Street to US 56	
Jurisdiction:	KDOT	
Analysis Year:	2030	
Description: NEPA Traffic Study		

_______________________Flow Inputs and Adjustments__________________________

Volume, V	5460	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1517	v
Trucks and buses	7	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.966	
Driver population factor, fp	1.00	
Flow rate, vp	2093	pc/h/ln

_______________________Speed Inputs and Adjustments_________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_______________________LOS and Performance Measures_________________________

Flow rate, vp	2093	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	62.9	mi/h
Number of lanes, N	3	
Density, D	33.3	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Wellsville North No Action - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:10:06 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	US 56 to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	4670	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1297	v
Trucks and buses	8	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.962	
Driver population factor, fp	1.00	
Flow rate, vp	1799	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	1799	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	67.9	mi/h
Number of lanes, N	3	
Density, D	26.5	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:10:06 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	Gardner Road to Waverly Road
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	3460	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	961	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1346	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	1.15	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	3.2	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	1346	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	19.2	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Wellsville North No Action - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:10:06 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	Waverly Road to Sunflower Road
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	3200	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	889	v
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.948	
Driver population factor, fp	1.00	
Flow rate, vp	1876	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1876	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	66.9	mi/h
Number of lanes, N	2	
Density, D	28.0	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/1/2008 4:10:06 PM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	Sunflower Road to Edgerton Road
Jurisdiction:	
Analysis Year:	2030
Description:	NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	2730	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	758	v
Trucks and buses	12	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.943	
Driver population factor, fp	1.00	
Flow rate, vp	1608	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1608	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	69.4	mi/h
Number of lanes, N	2	
Density, D	23.2	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

```
                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data____________________________________

Type of analysis                        Diverge
Number of lanes in freeway              2
Free-flow speed on freeway              70.0           mph
Volume on freeway                       2400           vph

_________________________________Off Ramp Data____________________________________

Side of freeway                         Right
Number of lanes in ramp                 1
Free-Flow speed on ramp                 35.0           mph
Volume on ramp                          160            vph
Length of first accel/decel lane        800            ft
Length of second accel/decel lane                      ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?               No
Volume on adjacent ramp                                vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                              ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                  Freeway    Ramp       Adjacent
                                                           Ramp
Volume, V (vph)                      2400       160                  vph
Peak-hour factor, PHF                0.90       0.90
Peak 15-min volume, v15              667        44                   v
Trucks and buses                     9          6                    %
Recreational vehicles                0          0                    %
Terrain type:                        Level      Rolling
     Grade                           0.00    %  0.00    %            %
     Length                          0.00    mi 0.00    mi           mi
Trucks and buses PCE, ET             1.5*       2.5
Recreational vehicle PCE, ER         1.2*       2.0
```

```
Heavy vehicle adjustment, fHV        0.957      0.917
Driver population factor, fP         1.00       1.00
Flow rate, vp                        2787       194                  pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2787   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum        LOS F?
     v  = v                2787          4800           No
      Fi   F
     v  = v - v            2593          4800           No
      FO   F   R
     v                     194           2000           No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable        Violation?
     v                2787          4600                 No
      12                                                                     !
_________________Level of Service Determination (if not F)___________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   21.0    pc/mi/ln
                        R                  12        D
Level of service for ramp-freeway junction areas of influence C

______________________________Speed Estimation________________________________

Intermediate speed variable,                D  = 0.445
                                             S
Space mean speed in ramp influence area,    S  = 57.5    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.5    mph
______________________________________________________________________________
```

```
                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data____________________________________

Type of analysis                        Merge
Number of lanes in freeway              2
Free-flow speed on freeway              70.0           mph
Volume on freeway                       2240           vph

__________________________________On Ramp Data____________________________________

Side of freeway                         Right
Number of lanes in ramp                 1
Free-flow speed on ramp                 35.0           mph
Volume on ramp                          680            vph
Length of first accel/decel lane        800            ft
Length of second accel/decel lane                      ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?               No
Volume on adjacent Ramp                                vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                              ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                  Freeway    Ramp       Adjacent
                                                           Ramp
Volume, V (vph)                      2240       680                  vph
Peak-hour factor, PHF                0.90       0.90
Peak 15-min volume, v15              622        189                  v
Trucks and buses                     9          2                    %
Recreational vehicles                0          0                    %
Terrain type:                        Level      Rolling
     Grade                                   %          %            %
     Length                                  mi         mi           mi
Trucks and buses PCE, ET             1.5*       2.5
Recreational vehicle PCE, ER         1.2*       2.0
```

```
Heavy vehicle adjustment, fHV        0.957      0.971
Driver population factor, fP         1.00       1.00
Flow rate, vp                        2601       778                  pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2601    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum        LOS F?
     v                     3379          4800           No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                2601          4400                 No
      12                                                                     !
_________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   26.5    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  C

______________________________Speed Estimation________________________________

Intermediate speed variable,                M  = 0.379
                                             S
Space mean speed in ramp influence area,    S  = 59.4    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 59.4    mph
______________________________________________________________________________
```

2030 Wellsville North No Action - AM Peak Hour - HCS Freeway Ramps

```
                HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Waverly Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2920          vph

________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              260           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp       Adjacent
                                                               Ramp
Volume, V (vph)                         2920        260                 vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 811         72                  v
Trucks and buses                        8           2                   %
Recreational vehicles                   0           0                   %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %           %
     Length                             0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.962       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3374        298                 pcph

_________________________Estimation of V12 Diverge Areas______________________

                L  =            (Equation 25-8 or 25-9)
                 EQ
                P  =    1.000   Using Equation  0
                 FD
                v  = v  + (v - v ) P  =  3374   pc/h
                 12   R     F   R   FD

______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v  = v                3374          4800            No
      Fi   F
     v  = v - v            3076          4800            No
      FO   F   R
     v                     298           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                3374          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   26.1    pc/mi/ln
                        R                 12          D
Level of service for ramp-freeway junction areas of influence C

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.455
                                              S
Space mean speed in ramp influence area,     S  = 57.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.3    mph
________________________________________________________________________________
```

```
                HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
E-mail:

________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Waverly Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2660          vph

_________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              600           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp       Adjacent
                                                               Ramp
Volume, V (vph)                         2660        600                 vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 739         167                 v
Trucks and buses                        8           2                   %
Recreational vehicles                   0           0                   %
Terrain type:                           Level       Rolling
     Grade                                      %           %           %
     Length                                     mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.962       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3074        687                 pcph

_________________________Estimation of V12 Merge Areas________________________

                L  =            (Equation 25-2 or 25-3)
                 EQ
                P  =    0.600   Using Equation  1
                 FM
                v  = v  (P  ) =  1844   pc/h
                 12   F   FM

______________________________Capacity Checks___________________________________

                           Actual        Maximum         LOS F?
     v                     3761          7200            No
      FO
     v     v               1230 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1844          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   19.9    pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.314
                                              S
Space mean speed in ramp influence area,     S  = 61.2    mph
                                              R
Space mean speed in outer lanes,             S  = 67.4    mph
                                              0
Space mean speed for all vehicles,           S  = 63.1    mph
________________________________________________________________________________
```

2030 Wellsville North No Action - AM Peak Hour - HCS Freeway Ramps

```
                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           3260           vph

________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              420            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         3260        420                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 906         117                   v
Trucks and buses                        7           2                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %             %
     Length                             0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.966       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3749        481                   pcph

________________________Estimation of V12 Diverge Areas________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.644   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  2586   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                3749          7200            No
      Fi   F
     v  = v - v            3268          7200            No
      FO   F   R
     v                     481           2000            No
      R
     v     v               1163 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2586          4600                   No
      12                                                                     !
________________Level of Service Determination (if not F)______________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   19.3    pc/mi/ln
                                        R             12      D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.471
                                              S
Space mean speed in ramp influence area,     S  = 56.8    mph
                                              R
Space mean speed in outer lanes,             S  = 76.2    mph
                                              0
Space mean speed for all vehicles,           S  = 61.7    mph
_______________________________________________________________________________
```

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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           2840           vph

_________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              1520           vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2840        1520                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 789         422                   v
Trucks and buses                        7           2                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                                      %           %             %
     Length                                     mi          mi            mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.966       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3266        1740                  pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1959   pc/h
                   12   F   FM

______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     5006          7200            No
      FO
     v     v               1307 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                1959          4400                   No
      12                                                                     !
________________Level of Service Determination (if not F)______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   28.5    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  D

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.423
                                              S
Space mean speed in ramp influence area,     S  = 58.2    mph
                                              R
Space mean speed in outer lanes,             S  = 67.1    mph
                                              0
Space mean speed for all vehicles,           S  = 60.3    mph
_______________________________________________________________________________
```

2030 Wellsville North No Action - AM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           4360          vph

________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              890           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         4360        890                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 1211        247                  v
Trucks and buses                        6           4                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00   mi   0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.971       0.943
Driver population factor, fP            1.00        1.00
Flow rate, vp                           4990        1048                 pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.587   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  3362   pc/h
                   12   R     F   R   FD

________________________________Capacity Checks________________________________

                              Actual        Maximum         LOS F?
     v  = v                   4990          7200            No
      Fi   F
     v  = v - v               3942          7200            No
      FO   F   R
     v                        1048          2000            No
      R
     v     v                  1628 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?              No
      3 or  av34
Is   v     v      > 1.5 v  /2               No
      3 or  av34         12
If yes, v    =                              (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                         Actual       Max Desirable          Violation?
     v                   3362         4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =    26.0    pc/mi/ln
                         R                 12          D
Level of service for ramp-freeway junction areas of influence C

_______________________________Speed Estimation________________________________

Intermediate speed variable,                 D  = 0.522
                                              S
Space mean speed in ramp influence area,     S  = 55.4    mph
                                              R
Space mean speed in outer lanes,             S  = 74.3    mph
                                              0
Space mean speed for all vehicles,           S  = 60.4    mph
_______________________________________________________________________________
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Phone:                                    Fax:
E-mail:

________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               8 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           5140          vph

_________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              550           vph
Length of first accel/decel lane            1000          ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         5140        550                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 1428        153                  v
Trucks and buses                        6           2                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                    mi           mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.971       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           5882        629                  pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.605   Using Equation  1
                   FM
                  v  = v  (P  ) =  3562   pc/h
                   12   F   FM

________________________________Capacity Checks________________________________

                              Actual        Maximum         LOS F?
     v                        6511          7200            No
      FO
     v     v                  2320 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?              No
      3 or  av34
Is   v     v      > 1.5 v  /2               No
      3 or  av34         12
If yes, v    =                              (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                         Actual       Max Desirable          Violation?
     v                   3562         4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =    31.6    pc/mi/ln
           R                  R           12            A
Level of service for ramp-freeway junction areas of influence  D

_______________________________Speed Estimation________________________________

Intermediate speed variable,                 M  = 0.509
                                              S
Space mean speed in ramp influence area,     S  = 55.8    mph
                                              R
Space mean speed in outer lanes,             S  = 63.3    mph
                                              0
Space mean speed for all vehicles,           S  = 58.2    mph
_______________________________________________________________________________
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2030 Wellsville North No Action - AM Peak Hour - HCS Freeway Ramps

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                HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                  Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               9 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           3470           vph

_________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              1670           vph
Length of first accel/decel lane            500            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         3470        1670                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 964         464                   v
Trucks and buses                        6           2                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                                     %           %          %
     Length                                    mi          mi         mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.971       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3971        1911                  pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.591   Using Equation  1
                   FM
                  v  = v  (P  ) =  2349   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v                     5882          7200            No
      FO
     v     v               1622 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                2349          4400                  No
      12                                                                     !
________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   34.7    pc/mi/ln
          R                   R          12              A
Level of service for ramp-freeway junction areas of influence  D

_____________________________Speed Estimation_________________________________

Intermediate speed variable,               M  = 0.562
                                            S
Space mean speed in ramp influence area,   S  = 54.3    mph
                                            R
Space mean speed in outer lanes,           S  = 66.0    mph
                                            0
Space mean speed for all vehicles,         S  = 57.1    mph
______________________________________________________________________________
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                HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                  Fax:
E-mail:

_______________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           3480           vph

________________________________Off Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     2
Free-Flow speed on ramp                     45.0           mph
Volume on ramp                              1610           vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane           500            ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         3480        1610                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 967         447                   v
Trucks and buses                        9           3                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %             %
     Length                             0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.957       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           4041        1869                  pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.450   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2846   pc/h
                   12   R      F   R   FD

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v  = v                4041          7200            No
      Fi   F
     v  = v - v            2172          7200            No
      FO   F   R
     v                     1869          4100            No
      R
     v     v               1195 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                2846          4600                  No
      12                                                                     !
________________Level of Service Determination (if not F)____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   9.8     pc/mi/ln
                      R                 12           D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation_________________________________

Intermediate speed variable,               D  = 0.466
                                            S
Space mean speed in ramp influence area,   S  = 56.9    mph
                                            R
Space mean speed in outer lanes,           S  = 76.0    mph
                                            0
Space mean speed for all vehicles,         S  = 61.5    mph
______________________________________________________________________________
```

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                  HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1870          vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              410           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1870        410                 vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 519         114                 v
Trucks and buses                        9           7                   %
Recreational vehicles                   0           0                   %
Terrain type:                           Level       Rolling
     Grade                                      %           %           %
     Length                                     mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.957       0.905
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2171        503                 pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1302   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     2674          7200            No
      FO
     v     v               869  pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1302          4400                   No
      12                                                                      !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   14.3    pc/mi/ln
         R                    R           12            A
Level of service for ramp-freeway junction areas of influence  B

____________________________Speed Estimation___________________________________

Intermediate speed variable,                 M  = 0.289
                                              S
Space mean speed in ramp influence area,     S  = 61.9    mph
                                              R
Space mean speed in outer lanes,             S  = 68.7    mph
                                              0
Space mean speed for all vehicles,           S  = 64.0    mph
________________________________________________________________________________
```

```
                  HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2280          vph

_________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              830           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2280        830                 vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 633         231                 v
Trucks and buses                        13          7                   %
Recreational vehicles                   0           0                   %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %           %
     Length                             0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV           0.939       0.905
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2698        1019                pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.646   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  2103   pc/h
                   12   R      F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                2698          7200            No
      Fi   F
     v  = v - v            1679          7200            No
      FO   F   R
     v                     1019          2000            No
      R
     v     v               595  pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                2103          4600                   No
      12                                                                      !
________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   15.1    pc/mi/ln
                        R                 12          D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation___________________________________

Intermediate speed variable,                 D  = 0.520
                                              S
Space mean speed in ramp influence area,     S  = 55.4    mph
                                              R
Space mean speed in outer lanes,             S  = 76.8    mph
                                              0
Space mean speed for all vehicles,           S  = 59.1    mph
________________________________________________________________________________
```

2030 Wellsville North No Action - AM Peak Hour - HCS Freeway Ramps

```
                  HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

________________________________Merge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data________________________________

Type of analysis                           Merge
Number of lanes in freeway                 3
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1450           vph

_________________________________On Ramp Data________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             180            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                    Freeway     Ramp       Adjacent
                                                              Ramp
Volume, V (vph)                        1450        180                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                403         50                   v
Trucks and buses                       13          3                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.939       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1716        209                  pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1029   pc/h
                   12   F   FM

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1925          7200            No
      FO
     v     v               687  pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                1029          4400                   No
      12                                                                  !
________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   10.0+   pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.278
                                              S
Space mean speed in ramp influence area,     S  = 62.2    mph
                                              R
Space mean speed in outer lanes,             S  = 69.3    mph
                                              0
Space mean speed for all vehicles,           S  = 64.6    mph
______________________________________________________________________________
```

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                  HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

________________________________Diverge Analysis_____________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               14 Waverly Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 3
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1630           vph

________________________________Off Ramp Data________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0           mph
Volume on ramp                             470            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                    Freeway     Ramp       Adjacent
                                                              Ramp
Volume, V (vph)                        1630        470                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                453         131                  v
Trucks and buses                       15          2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.930       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1947        538                  pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.687   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  1505   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1947          7200            No
      Fi   F
     v  = v - v            1409          7200            No
      FO   F   R
     v                     538           2000            No
      R
     v     v               442  pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1505          4600                   No
      12                                                                  !
________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   10.0-   pc/mi/ln
                                         R           12    D
Level of service for ramp-freeway junction areas of influence A

____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.476
                                              S
Space mean speed in ramp influence area,     S  = 56.7    mph
                                              R
Space mean speed in outer lanes,             S  = 76.8    mph
                                              0
Space mean speed for all vehicles,           S  = 60.2    mph
______________________________________________________________________________
```

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                 HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

________________________________Merge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               15 Waverly Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          1160          vph

_________________________________On Ramp Data_______________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0          mph
Volume on ramp                             110           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1160        110                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                322         31                  v
Trucks and buses                       15          2                   %
Recreational vehicles                  0           0                   %
Terrain type:                          Level       Rolling
    Grade                                   %           %           %
    Length                                  mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.930       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1386        126                    pcph

________________________Estimation of V12 Merge Areas________________________

                 L  =            (Equation 25-2 or 25-3)
                  EQ
                 P  =    1.000   Using Equation  0
                  FM
                 v  = v  (P  ) =  1386   pc/h
                  12   F   FM

______________________________Capacity Checks_______________________________

                           Actual        Maximum        LOS F?
     v                     1512          4800           No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                1386          4400                  No
      12                                                                  !
________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   12.2    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation________________________________

Intermediate speed variable,                  M  = 0.283
                                               S
Space mean speed in ramp influence area,      S  = 62.1    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 62.1    mph
_____________________________________________________________________________
```

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Phone:                                    Fax:
E-mail:

________________________________Diverge Analysis____________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               16 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          1270          vph

________________________________Off Ramp Data_______________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0          mph
Volume on ramp                             170           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)__________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1270        170                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                353         47                  v
Trucks and buses                       19          4                   %
Recreational vehicles                  0           0                   %
Terrain type:                          Level       Rolling
    Grade                              0.00    %   0.00    %           %
    Length                             0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.913       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1545        200                    pcph

________________________Estimation of V12 Diverge Areas______________________

                 L  =            (Equation 25-8 or 25-9)
                  EQ
                 P  =    1.000   Using Equation  0
                  FD
                 v  = v  + (v - v ) P  =  1545   pc/h
                  12   R     F   R   FD

______________________________Capacity Checks_______________________________

                           Actual        Maximum        LOS F?
     v  = v                1545          4800           No
      Fi   F
     v  = v - v            1345          4800           No
      FO   F   R
     v                     200           2000           No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

_____________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                1545          4600                  No
      12                                                                  !
________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   10.3    pc/mi/ln
                                          R           12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation________________________________

Intermediate speed variable,                  D  = 0.446
                                               S
Space mean speed in ramp influence area,      S  = 57.5    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 57.5    mph
_____________________________________________________________________________
```

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Phone:                                    Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               17 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          1100          vph

_________________________________On Ramp Data_________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0          mph
Volume on ramp                             90            vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1100        90                    vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               306         25                    v
Trucks and buses                      19          2                     %
Recreational vehicles                 0           0                     %
Terrain type:                         Level       Rolling
     Grade                                    %           %           %
     Length                                  mi          mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

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Heavy vehicle adjustment, fHV           0.913       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1338        103                   pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1338   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1441          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                1338          4400                  No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   11.7    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.281
                                              S
Space mean speed in ramp influence area,     S  = 62.1    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.1    mph
_______________________________________________________________________________
```

2030 Wellsville North No Action - PM Peak Hour - HCS Freeway Ramps

```
                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data____________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1350           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0           mph
Volume on ramp                             90             vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1350        90                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                375         25                   v
Trucks and buses                       21          2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.905       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1658        103                  pcph

_________________________Estimation of V12 Diverge Areas__________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1658   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks____________________________________

                             Actual        Maximum         LOS F?
     v  = v                  1658          4800            No
      Fi   F
     v  = v - v              1555          4800            No
      FO   F   R
     v                       103           2000            No
      R
     v     v                 0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?            No
      3 or  av34
Is   v     v       > 1.5 v  /2             No
      3 or  av34          12
If yes, v    =                             (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                        Actual        Max Desirable          Violation?
     v                  1658          4600                   No
      12                                                                          !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   11.3    pc/mi/ln
                                          R             12         D
Level of service for ramp-freeway junction areas of influence B

________________________________Speed Estimation__________________________________

Intermediate speed variable,                  D  = 0.437
                                               S
Space mean speed in ramp influence area,      S  = 57.8    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 57.8    mph
__________________________________________________________________________________
```

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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data____________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0           mph
Volume on freeway                          1260           vph

__________________________________On Ramp Data____________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0           mph
Volume on ramp                             280            vph
Length of first accel/decel lane           800            ft
Length of second accel/decel lane                         ft

_________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1260        280                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                350         78                   v
Trucks and buses                       21          4                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.905       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1547        330                  pcph

_________________________Estimation of V12 Merge Areas____________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1547   pc/h
                   12   F   FM

_______________________________Capacity Checks____________________________________

                             Actual        Maximum         LOS F?
     v                       1877          4800            No
      FO
     v     v                 0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?            No
      3 or  av34
Is   v     v       > 1.5 v  /2             No
      3 or  av34          12
If yes, v    =                             (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                        Actual        Max Desirable          Violation?
     v                  1547          4400                   No
      12                                                                          !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   14.9    pc/mi/ln
               R              R            12            A
Level of service for ramp-freeway junction areas of influence  B

________________________________Speed Estimation__________________________________

Intermediate speed variable,                  M  = 0.290
                                               S
Space mean speed in ramp influence area,      S  = 61.9    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 61.9    mph
__________________________________________________________________________________
```

2030 Wellsville North No Action - PM Peak Hour - HCS Freeway Ramps

```
                 HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Waverly Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1540           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              100            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1540        100                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                428         28                   v
Trucks and buses                       19          2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.913       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1874        114                         pcph

_________________________Estimation of V12 Diverge Areas________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1874   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                1874          4800            No
      Fi   F
     v  = v - v            1760          4800            No
      FO   F   R
     v                     114           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                1874          4600                   No
      12                                                                          !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   13.2    pc/mi/ln
                                          R             12         D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation__________________________________

Intermediate speed variable,                  D  = 0.438
                                               S
Space mean speed in ramp influence area,      S  = 57.7     mph
                                               R
Space mean speed in outer lanes,              S  =  N/A     mph
                                               0
Space mean speed for all vehicles,            S  = 57.7     mph
________________________________________________________________________________
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                 HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Waverly Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1440           vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              520            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)_____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions____________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        1440        520                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                400         144                  v
Trucks and buses                       19          2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.913       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1752        595                         pcph

_________________________Estimation of V12 Merge Areas__________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1051   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     2347          7200            No
      FO
     v     v               701  pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                1051          4400                   No
      12                                                                          !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L  =   13.0    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation__________________________________

Intermediate speed variable,                  M  = 0.285
                                               S
Space mean speed in ramp influence area,      S  = 62.0     mph
                                               R
Space mean speed in outer lanes,              S  = 69.3     mph
                                               0
Space mean speed for all vehicles,            S  = 64.0     mph
________________________________________________________________________________
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                HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 3
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          1960          vph

________________________________Off Ramp Data_________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0          mph
Volume on ramp                             210           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp       Adjacent
                                                              Ramp
Volume, V (vph)                        1960        210                 vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                544         58                  v
Trucks and buses                       16          5                   %
Recreational vehicles                  0           0                   %
Terrain type:                          Level       Rolling
    Grade                              0.00    %   0.00    %           %
    Length                             0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.926       0.930
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2352        251                 pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.690   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  1700   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                             Actual        Maximum         LOS F?
     v  = v                  2352          7200            No
      Fi   F
     v  = v - v              2101          7200            No
      FO   F   R
     v                       251           2000            No
      R
     v     v                 652  pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?            No
      3 or  av34
Is   v     v       > 1.5 v  /2             No
      3 or  av34          12
If yes, v    =                             (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                        Actual        Max Desirable          Violation?
     v                  1700          4600                   No
      12                                                                     !
________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   11.7    pc/mi/ln
                         R                  12          D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation________________________________

Intermediate speed variable,                 D  = 0.451
                                              S
Space mean speed in ramp influence area,     S  = 57.4    mph
                                              R
Space mean speed in outer lanes,             S  = 76.8    mph
                                              0
Space mean speed for all vehicles,           S  = 61.7    mph
_______________________________________________________________________________
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                HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                    Fax:
E-mail:

________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                           Merge
Number of lanes in freeway                 3
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          1750          vph

_________________________________On Ramp Data_________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0          mph
Volume on ramp                             1010          vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp       Adjacent
                                                              Ramp
Volume, V (vph)                        1750        1010                vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                486         281                 v
Trucks and buses                       16          4                   %
Recreational vehicles                  0           0                   %
Terrain type:                          Level       Rolling
    Grade                                      %           %           %
    Length                                     mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.926       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2100        1190                pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1260   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                             Actual        Maximum         LOS F?
     v                       3290          7200            No
      FO
     v     v                 840  pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v     > 2700 pc/h?              No
      3 or  av34
Is   v     v     > 1.5 v  /2               No
      3 or  av34        12
If yes, v    =                             (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                        Actual        Max Desirable          Violation?
     v                  1260          4400                   No
      12                                                                     !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   19.0    pc/mi/ln
                              R          12             A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation________________________________

Intermediate speed variable,                 M  = 0.310
                                              S
Space mean speed in ramp influence area,     S  = 61.3    mph
                                              R
Space mean speed in outer lanes,             S  = 68.8    mph
                                              0
Space mean speed for all vehicles,           S  = 63.1    mph
_______________________________________________________________________________
```

2030 Wellsville North No Action - PM Peak Hour - HCS Freeway Ramps

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                HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                              Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2760          vph

________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              490           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2760        490                 vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 767         136                 v
Trucks and buses                        12          8                   %
Recreational vehicles                   0           0                   %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %           %
     Length                             0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.943       0.893
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3251        610                     pcph

_________________________Estimation of V12 Diverge Areas________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.651   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  2328   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                              Actual        Maximum         LOS F?
     v  = v                   3251          7200            No
      Fi   F
     v  = v - v               2641          7200            No
      FO   F   R
     v                        610           2000            No
      R
     v     v                  923  pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?              No
      3 or  av34
Is   v     v      > 1.5 v  /2               No
      3 or  av34        12
If yes, v    =                              (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                         Actual        Max Desirable         Violation?
     v                   2328          4600                  No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   17.1    pc/mi/ln
                      R                  12          D
Level of service for ramp-freeway junction areas of influence B

_______________________________Speed Estimation_________________________________

Intermediate speed variable,                 D  = 0.483
                                              S
Space mean speed in ramp influence area,     S  = 56.5    mph
                                              R
Space mean speed in outer lanes,             S  = 76.8    mph
                                              0
Space mean speed for all vehicles,           S  = 61.1    mph
________________________________________________________________________________
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                HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                              Fax:
E-mail:

________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               8 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           3620          vph

_________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              580           vph
Length of first accel/decel lane            1000          ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         3620        580                 vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 1006        161                 v
Trucks and buses                        12          3                   %
Recreational vehicles                   0           0                   %
Terrain type:                           Level       Rolling
     Grade                                      %           %           %
     Length                                     mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.943       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           4264        673                     pcph

_________________________Estimation of V12 Merge Areas__________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.605   Using Equation  1
                   FM
                  v  = v  (P  ) =  2582   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                              Actual        Maximum         LOS F?
     v                        4937          7200            No
      FO
     v     v                  1682 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?              No
      3 or  av34
Is   v     v      > 1.5 v  /2               No
      3 or  av34        12
If yes, v    =                              (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area_____________________
                         Actual        Max Desirable         Violation?
     v                   2582          4400                  No
      12                                                                      !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   24.3    pc/mi/ln
          R                   R          12             A
Level of service for ramp-freeway junction areas of influence  C

_______________________________Speed Estimation_________________________________

Intermediate speed variable,                 M  = 0.352
                                              S
Space mean speed in ramp influence area,     S  = 60.1    mph
                                              R
Space mean speed in outer lanes,             S  = 65.7    mph
                                              0
Space mean speed for all vehicles,           S  = 61.9    mph
________________________________________________________________________________
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2030 Wellsville North No Action - PM Peak Hour - HCS Freeway Ramps

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                 HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                  Fax:
E-mail:

________________________________Merge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               9 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                         Merge
Number of lanes in freeway               3
Free-flow speed on freeway               70.0          mph
Volume on freeway                        2270          vph

_________________________________On Ramp Data_______________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-flow speed on ramp                  35.0          mph
Volume on ramp                           1350          vph
Length of first accel/decel lane         500           ft
Length of second accel/decel lane                      ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                No
Volume on adjacent Ramp                                vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                              ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2270        1350                 vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 631         375                  v
Trucks and buses                        12          3                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
    Grade                                       %           %           %
    Length                                      mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.943       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2674        1568                 pcph

________________________Estimation of V12 Merge Areas_______________________

                 L  =            (Equation 25-2 or 25-3)
                  EQ
                 P  =    0.591   Using Equation  1
                  FM
                 v  = v  (P  ) =  1582   pc/h
                  12   F   FM

______________________________Capacity Checks_______________________________

                          Actual        Maximum         LOS F?
     v                    4242          7200            No
      FO
     v     v              1092 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?          No
      3 or  av34
Is   v     v      > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                          (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area____________________
                     Actual        Max Desirable          Violation?
     v               1582          4400                   No
      12                                                               !
_______________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   26.2    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  C

____________________________Speed Estimation________________________________

Intermediate speed variable,              M  = 0.377
                                           S
Space mean speed in ramp influence area,  S  = 59.4    mph
                                           R
Space mean speed in outer lanes,          S  = 67.9    mph
                                           0
Space mean speed for all vehicles,        S  = 61.4    mph
____________________________________________________________________________
```

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                 HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                  Fax:
E-mail:

________________________________Diverge Analysis____________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_______________________________

Type of analysis                         Diverge
Number of lanes in freeway               3
Free-flow speed on freeway               70.0          mph
Volume on freeway                        5460          vph

________________________________Off Ramp Data_______________________________

Side of freeway                          Right
Number of lanes in ramp                  2
Free-Flow speed on ramp                  45.0          mph
Volume on ramp                           1730          vph
Length of first accel/decel lane         800           ft
Length of second accel/decel lane        500           ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                No
Volume on adjacent ramp                                vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                              ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         5460        1730                 vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 1517        481                  v
Trucks and buses                        7           2                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
    Grade                               0.00    %   0.00    %           %
    Length                              0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.966       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           6279        1980                 pcph

________________________Estimation of V12 Diverge Areas_____________________

                 L  =            (Equation 25-8 or 25-9)
                  EQ
                 P  =    0.450   Using Equation  0
                  FD
                 v  = v  + (v - v ) P  =  3915   pc/h
                  12   R     F   R   FD

______________________________Capacity Checks_______________________________

                          Actual        Maximum         LOS F?
     v  = v               6279          7200            No
      Fi   F
     v  = v - v           4299          7200            No
      FO   F   R
     v                    1980          4100            No
      R
     v     v              2364 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?          No
      3 or  av34
Is   v     v      > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                          (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area__________________
                     Actual        Max Desirable          Violation?
     v               3915          4600                   No
      12                                                               !
_______________Level of Service Determination (if not F)___________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   19.0    pc/mi/ln
                       R                 12          D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation________________________________

Intermediate speed variable,              D  = 0.476
                                           S
Space mean speed in ramp influence area,  S  = 56.7    mph
                                           R
Space mean speed in outer lanes,          S  = 71.5    mph
                                           0
Space mean speed for all vehicles,        S  = 61.5    mph
____________________________________________________________________________
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                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                          Merge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0          mph
Volume on freeway                         3730          vph

__________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            940           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       3730        940                   vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               1036        261                   v
Trucks and buses                      7           3                     %
Recreational vehicles                 0           0                     %
Terrain type:                         Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
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Heavy vehicle adjustment, fHV         0.966       0.957
Driver population factor, fP          1.00        1.00
Flow rate, vp                         4289        1091                  pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  2573   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v                     5380          7200            No
      FO
     v     v               1716 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                2573          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   28.5    pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  D

____________________________Speed Estimation__________________________________

Intermediate speed variable,               M  = 0.417
                                            S
Space mean speed in ramp influence area,   S  = 58.3    mph
                                            R
Space mean speed in outer lanes,           S  = 65.6    mph
                                            0
Space mean speed for all vehicles,         S  = 60.5    mph
______________________________________________________________________________
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                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

_________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                          Diverge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0          mph
Volume on freeway                         4670          vph

_________________________________Off Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            1610          vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       4670        1610                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               1297        447                   v
Trucks and buses                      8           3                     %
Recreational vehicles                 0           0                     %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00    %           %
     Length                           0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.962       0.957
Driver population factor, fP          1.00        1.00
Flow rate, vp                         5396        1869                  pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.539   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  3770   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v  = v                5396          7200            No
      Fi   F
     v  = v - v            3527          7200            No
      FO   F   R
     v                     1869          2000            No
      R
     v     v               1626 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                3770          4600                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density,                D = 4.252 + 0.0086 v  - 0.009  L   =   29.5    pc/mi/ln
                                           R           12           D
Level of service for ramp-freeway junction areas of influence D

____________________________Speed Estimation__________________________________

Intermediate speed variable,               D  = 0.596
                                            S
Space mean speed in ramp influence area,   S  = 53.3    mph
                                            R
Space mean speed in outer lanes,           S  = 74.3    mph
                                            0
Space mean speed for all vehicles,         S  = 58.3    mph
______________________________________________________________________________
```

```
                 HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           3060          vph

_________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              400           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         3060        400                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 850         111                   v
Trucks and buses                        8           4                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                                      %           %           %
     Length                                     mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.962       0.943
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3536        471                   pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  2121   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual         Maximum          LOS F?
     v                     4007           7200             No
      FO
     v     v               1415 pc/h      (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?            No
      3 or  av34
Is   v     v      > 1.5 v  /2             No
      3 or  av34         12
If yes, v    =                            (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                2121          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   20.5    pc/mi/ln
          R                 R            12             A
Level of service for ramp-freeway junction areas of influence  C

______________________________Speed Estimation________________________________

Intermediate speed variable,                M  = 0.317
                                             S
Space mean speed in ramp influence area,    S  = 61.1    mph
                                             R
Space mean speed in outer lanes,            S  = 66.7    mph
                                             0
Space mean speed for all vehicles,          S  = 63.0    mph
______________________________________________________________________________
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                 HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                    Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               14 Waverly Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           3460          vph

________________________________Off Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              610           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         3460        610                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 961         169                   v
Trucks and buses                        10          2                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %           %
     Length                             0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.952       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           4037        698                   pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.627   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  2791   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                           Actual         Maximum          LOS F?
     v  = v                4037           7200             No
      Fi   F
     v  = v - v            3339           7200             No
      FO   F   R
     v                     698            2000             No
      R
     v     v               1246 pc/h      (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?            No
      3 or  av34
Is   v     v      > 1.5 v  /2             No
      3 or  av34         12
If yes, v    =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                2791          4600                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   21.1    pc/mi/ln
                        R                 12          D
Level of service for ramp-freeway junction areas of influence C

______________________________Speed Estimation________________________________

Intermediate speed variable,                D  = 0.491
                                             S
Space mean speed in ramp influence area,    S  = 56.3    mph
                                             R
Space mean speed in outer lanes,            S  = 75.8    mph
                                             0
Space mean speed for all vehicles,          S  = 61.1    mph
______________________________________________________________________________
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2030 Wellsville North No Action - PM Peak Hour - HCS Freeway Ramps

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                 HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               15 Waverly Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                           Merge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          2850          vph

_________________________________On Ramp Data_________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-flow speed on ramp                    35.0          mph
Volume on ramp                             350           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        2850        350                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                792         97                   v
Trucks and buses                       10          2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                    %           %           %
     Length                                   mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.952       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3325        401                  pcph

________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  3325   pc/h
                   12   F   FM

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     3726          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v         > 2700 pc/h?        No
      3 or  av34
Is   v     v         > 1.5 v  /2         No
      3 or  av34            12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                3325          4400                   No
      12                                                                     !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   29.3    pc/mi/ln
                             R            12            A
Level of service for ramp-freeway junction areas of influence  D

___________________________Speed Estimation___________________________________

Intermediate speed variable,               M  = 0.427
                                            S
Space mean speed in ramp influence area,   S  = 58.0    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 58.0    mph
______________________________________________________________________________
```

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                 HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               16 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                           Diverge
Number of lanes in freeway                 2
Free-flow speed on freeway                 70.0          mph
Volume on freeway                          3200          vph

________________________________Off Ramp Data_________________________________

Side of freeway                            Right
Number of lanes in ramp                    1
Free-Flow speed on ramp                    35.0          mph
Volume on ramp                             660           vph
Length of first accel/decel lane           800           ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                  No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        3200        660                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                889         183                  v
Trucks and buses                       11          2                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00     %  0.00     %           %
     Length                            0.00    mi  0.00     mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.948       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3751        755                  pcph

________________________Estimation of V12 Diverge Areas_______________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  3751   pc/h
                   12   R      F   R   FD

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                3751          4800            No
      Fi   F
     v  = v - v            2996          4800            No
      FO   F   R
     v                     755           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v         > 2700 pc/h?        No
      3 or  av34
Is   v     v         > 1.5 v  /2         No
      3 or  av34            12
If yes, v    =                           (Equation 25-18)
         12A

_____________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                3751          4600                   No
      12                                                                     !
________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   29.3    pc/mi/ln
                                          R          12         D
Level of service for ramp-freeway junction areas of influence D

___________________________Speed Estimation___________________________________

Intermediate speed variable,               D  = 0.496
                                            S
Space mean speed in ramp influence area,   S  = 56.1    mph
                                            R
Space mean speed in outer lanes,           S  =  N/A    mph
                                            0
Space mean speed for all vehicles,         S  = 56.1    mph
______________________________________________________________________________
```

2030 Wellsville North No Action - PM Peak Hour - HCS Freeway Ramps

```
              HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/1/2008 4:04:23 PM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               17 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2540          vph

_________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              190           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        2540        190                   vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                706         53                    v
Trucks and buses                       11          4                     %
Recreational vehicles                  0           0                     %
Terrain type:                          Level       Rolling
    Grade                                      %           %           %
    Length                                     mi          mi          mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.948       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2977        224                      pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2977   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     3201          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2977          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   25.3    pc/mi/ln
                              R             12            A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.361
                                              S
Space mean speed in ramp influence area,     S  = 59.9    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 59.9    mph
_______________________________________________________________________________
```

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

______________Operational Analysis______________

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/2/2008 9:27:05 AM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: Edgerton Road to Sunflower Road
Jurisdiction:
Analysis Year: 2030
Description: NEPA Traffic Study

______________Flow Inputs and Adjustments______________

Volume, V	2410	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	669	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1399	pc/h/ln

______________Speed Inputs and Adjustments______________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

______________LOS and Performance Measures______________

Flow rate, vp	1399	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	20.0	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

______________Operational Analysis______________

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/2/2008 9:27:05 AM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: Sunflower Road to Waverly Road
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

______________Flow Inputs and Adjustments______________

Volume, V	3140	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	872	v
Trucks and buses	12	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.943	
Driver population factor, fp	1.00	
Flow rate, vp	1849	pc/h/ln

______________Speed Inputs and Adjustments______________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

______________LOS and Performance Measures______________

Flow rate, vp	1849	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	67.3	mi/h
Number of lanes, N	2	
Density, D	27.5	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 9:27:05 AM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Waverly Road to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	3470	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	964	v
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.948	
Driver population factor, fp	1.00	
Flow rate, vp	1356	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	1.15	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	3.2	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	1356	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	19.4	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 9:27:05 AM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Northbound
From/To:	Gardner Road to US 56
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	4570	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1269	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1769	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	1769	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	68.2	mi/h
Number of lanes, N	3	
Density, D	25.9	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Wellsville North Alternative - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/2/2008 9:27:05 AM
Analysis Time Period: AM
Freeway/Direction: I-35 Northbound
From/To: US 56 to 151st Street
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	5890	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1636	v
Trucks and buses	7	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.966	
Driver population factor, fp	1.00	
Flow rate, vp	2258	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2258	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	58.4	mi/h
Number of lanes, N	3	
Density, D	38.7	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

Operational Analysis

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/2/2008 9:27:05 AM
Analysis Time Period: AM
Freeway/Direction: I-35 Southbound
From/To: 151Street to US 56
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

Flow Inputs and Adjustments

Volume, V	3610	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1003	v
Trucks and buses	12	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.943	
Driver population factor, fp	1.00	
Flow rate, vp	1417	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1417	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	20.3	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Wellsville North Alternative - AM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 9:27:05 AM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	US 56 to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	2430	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	675	v
Trucks and buses	17	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.922	
Driver population factor, fp	1.00	
Flow rate, vp	977	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	977	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	14.0	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_____Operational Analysis_____

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 9:27:05 AM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	Gardner Road to Waverly Road
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

_____Flow Inputs and Adjustments_____

Volume, V	1790	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	497	v
Trucks and buses	19	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.913	
Driver population factor, fp	1.00	
Flow rate, vp	726	pc/h/ln

_____Speed Inputs and Adjustments_____

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	1.15	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	3.2	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_____LOS and Performance Measures_____

Flow rate, vp	726	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	10.4	pc/mi/ln
Level of service, LOS	A	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Wellsville North Alternative - AM Peak Hour - HCS Freeway Mainline

Level of service, LOS B

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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_______________________Operational Analysis___________________________________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 9:27:05 AM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	Waverly Road to Sunflower Road
Jurisdiction:	KDOT
Analysis Year:	2030
Description: NEPA Traffic Study	

_______________________Flow Inputs and Adjustments__________________________

Volume, V	1440	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	400	v
Trucks and buses	24	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.893	
Driver population factor, fp	1.00	
Flow rate, vp	896	pc/h/ln

_______________________Speed Inputs and Adjustments_________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______________________LOS and Performance Measures_________________________

Flow rate, vp	896	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	12.8	pc/mi/ln

Level of service, LOS A

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

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_______________________Operational Analysis___________________________________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 9:27:05 AM
Analysis Time Period:	AM
Freeway/Direction:	I-35 Southbound
From/To:	Sunflower Road to Edgerton Road
Jurisdiction:	
Analysis Year:	2030
Description: NEPA Traffic Study	

_______________________Flow Inputs and Adjustments__________________________

Volume, V	1200	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	333	v
Trucks and buses	20	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.909	
Driver population factor, fp	1.00	
Flow rate, vp	733	pc/h/ln

_______________________Speed Inputs and Adjustments_________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

_______________________LOS and Performance Measures_________________________

Flow rate, vp	733	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	10.5	pc/mi/ln

2030 Wellsville North Alternative - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

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E-mail:

______________________Operational Analysis______________________________

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/2/2008 9:27:05 AM
Analysis Time Period: PM
Freeway/Direction: I-35 Northbound
From/To: Edgerton Road to Sunflower Road
Jurisdiction:
Analysis Year: 2030
Description: NEPA Traffic Study

______________________Flow Inputs and Adjustments_________________________

Volume, V	1370	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	381	v
Trucks and buses	22	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.901	
Driver population factor, fp	1.00	
Flow rate, vp	845	pc/h/ln

______________________Speed Inputs and Adjustments________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

______________________LOS and Performance Measures________________________

Flow rate, vp	845	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	12.1	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

______________________Operational Analysis______________________________

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/2/2008 9:27:05 AM
Analysis Time Period: PM
Freeway/Direction: I-35 Northbound
From/To: Sunflower Road to Waverly Road
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

______________________Flow Inputs and Adjustments_________________________

Volume, V	1700	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	472	v
Trucks and buses	0	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	1.000	
Driver population factor, fp	1.00	
Flow rate, vp	944	pc/h/ln

______________________Speed Inputs and Adjustments________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	0.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Rural Freeway	

______________________LOS and Performance Measures________________________

Flow rate, vp	944	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	13.5	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Wellsville North Alternative - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_______________________Operational Analysis_________________________________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 9:27:05 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Waverly Road to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

_______________________Flow Inputs and Adjustments__________________________

Volume, V	2110	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	586	v
Trucks and buses	21	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.905	
Driver population factor, fp	1.00	
Flow rate, vp	864	pc/h/ln

_______________________Speed Inputs and Adjustments_________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	1.15	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	3.2	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_______________________LOS and Performance Measures_________________________

Flow rate, vp	864	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	12.3	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_______________________Operational Analysis_________________________________

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 9:27:05 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Northbound
From/To:	Gardner Road to US 56
Jurisdiction:	KDOT
Analysis Year:	2030
Description:	NEPA Traffic Study

_______________________Flow Inputs and Adjustments__________________________

Volume, V	2910	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	808	v
Trucks and buses	17	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.922	
Driver population factor, fp	1.00	
Flow rate, vp	1169	pc/h/ln

_______________________Speed Inputs and Adjustments_________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_______________________LOS and Performance Measures_________________________

Flow rate, vp	1169	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	16.7	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Wellsville North Alternative - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_______Operational Analysis_______

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/2/2008 9:27:05 AM
Analysis Time Period: PM
Freeway/Direction: I-35 Northbound
From/To: US 56 to 151st Street
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

_______Flow Inputs and Adjustments_______

Volume, V	4340	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1206	v
Trucks and buses	12	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.943	
Driver population factor, fp	1.00	
Flow rate, vp	1704	pc/h/ln

_______Speed Inputs and Adjustments_______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_______LOS and Performance Measures_______

Flow rate, vp	1704	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	68.8	mi/h
Number of lanes, N	3	
Density, D	24.8	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_______Operational Analysis_______

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/2/2008 9:27:05 AM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: 151Street to US 56
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

_______Flow Inputs and Adjustments_______

Volume, V	5620	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1561	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2186	pc/h/ln

_______Speed Inputs and Adjustments_______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_______LOS and Performance Measures_______

Flow rate, vp	2186	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	60.5	mi/h
Number of lanes, N	3	
Density, D	36.1	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Wellsville North Alternative - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_______Operational Analysis_______

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 9:27:05 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	US 56 to Gardner Road
Jurisdiction:	KDOT
Analysis Year:	2030

Description: NEPA Traffic Study

_______Flow Inputs and Adjustments_______

Volume, V	4830	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1342	v
Trucks and buses	12	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.943	
Driver population factor, fp	1.00	
Flow rate, vp	1896	pc/h/ln

_______Speed Inputs and Adjustments_______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_______LOS and Performance Measures_______

Flow rate, vp	1896	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	66.6	mi/h
Number of lanes, N	3	
Density, D	28.5	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_______Operational Analysis_______

Analyst:	Tom Hiles
Agency or Company:	HDR Inc.
Date Performed:	4/2/2008 9:27:05 AM
Analysis Time Period:	PM
Freeway/Direction:	I-35 Southbound
From/To:	Gardner Road to Waverly Road
Jurisdiction:	KDOT
Analysis Year:	2030

Description: NEPA Traffic Study

_______Flow Inputs and Adjustments_______

Volume, V	3620	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	1006	v
Trucks and buses	15	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.930	
Driver population factor, fp	1.00	
Flow rate, vp	1441	pc/h/ln

_______Speed Inputs and Adjustments_______

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	1.15	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	3.2	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_______LOS and Performance Measures_______

Flow rate, vp	1441	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	69.9	mi/h
Number of lanes, N	3	
Density, D	20.6	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Wellsville North Alternative - PM Peak Hour - HCS Freeway Mainline

HCS+: Basic Freeway Segments Release 5.21

Phone: Fax:
E-mail:

_______________________Operational Analysis_________________________________

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/2/2008 9:27:05 AM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: Waverly Road to Sunflower Road
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

_______________________Flow Inputs and Adjustments__________________________

Volume, V	3360	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	933	v
Trucks and buses	16	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.926	
Driver population factor, fp	1.00	
Flow rate, vp	2016	pc/h/ln

_______________________Speed Inputs and Adjustments_________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_______________________LOS and Performance Measures_________________________

Flow rate, vp	2016	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	64.5	mi/h
Number of lanes, N	2	
Density, D	31.2	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

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E-mail:

_______________________Operational Analysis_________________________________

Analyst: Tom Hiles
Agency or Company: HDR Inc.
Date Performed: 4/2/2008 9:27:05 AM
Analysis Time Period: PM
Freeway/Direction: I-35 Southbound
From/To: Sunflower Road to Edgerton Road
Jurisdiction:
Analysis Year: 2030
Description: NEPA Traffic Study

_______________________Flow Inputs and Adjustments__________________________

Volume, V	2700	veh/h
Peak-hour factor, PHF	0.90	
Peak 15-min volume, v15	750	v
Trucks and buses	13	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.939	
Driver population factor, fp	1.00	
Flow rate, vp	1598	pc/h/ln

_______________________Speed Inputs and Adjustments_________________________

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	70.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	70.0	mi/h
	Urban Freeway	

_______________________LOS and Performance Measures_________________________

Flow rate, vp	1598	pc/h/ln
Free-flow speed, FFS	70.0	mi/h
Average passenger-car speed, S	69.4	mi/h
Number of lanes, N	2	
Density, D	23.0	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

2030 Wellsville North Alternative - AM Peak Hour - HCS Freeway Ramps

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                   HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           2410           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              165            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        2410        165                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                669         46                   v
Trucks and buses                       9           8                    %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                             0.00    %   0.00    %            %
     Length                            0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.957       0.893
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2798        205                  pcph

_________________________Estimation of V12 Diverge Areas________________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2798   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                2798          4800            No
      Fi   F
     v  = v - v            2593          4800            No
      FO   F   R
     v                     205           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable           Violation?
     v                2798          4600                    No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density,             D = 4.252 + 0.0086 v  - 0.009  L   =   21.1    pc/mi/ln
                      R                 12         D
Level of service for ramp-freeway junction areas of influence C

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.446
                                              S
Space mean speed in ramp influence area,     S  = 57.5    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.5    mph
________________________________________________________________________________
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Phone:                                   Fax:
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_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           2245           vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              900            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                    Freeway     Ramp        Adjacent
                                                               Ramp
Volume, V (vph)                        2245        900                  vph
Peak-hour factor, PHF                  0.90        0.90
Peak 15-min volume, v15                624         250                  v
Trucks and buses                       9           19                   %
Recreational vehicles                  0           0                    %
Terrain type:                          Level       Rolling
     Grade                                     %           %            %
     Length                                    mi          mi           mi
Trucks and buses PCE, ET               1.5*        2.5
Recreational vehicle PCE, ER           1.2*        2.0
Heavy vehicle adjustment, fHV          0.957       0.778
Driver population factor, fP           1.00        1.00
Flow rate, vp                          2607        1285                 pcph

_________________________Estimation of V12 Merge Areas__________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2607   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     3892          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable           Violation?
     v                2607          4400                    No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   30.2    pc/mi/ln
          R                   R          12            A
Level of service for ramp-freeway junction areas of influence  D

______________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.456
                                              S
Space mean speed in ramp influence area,     S  = 57.2    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.2    mph
________________________________________________________________________________
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2030 Wellsville North Alternative - AM Peak Hour - HCS Freeway Ramps

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                 HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                      Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Waverly Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           3140           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              270            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         3140        270                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 872         75                   v
Trucks and buses                        12          3                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.943       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3698        314                   pcph

_________________________Estimation of V12 Diverge Areas_________________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  3698   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks____________________________________

                           Actual        Maximum         LOS F?
     v  = v                3698          4800            No
      Fi   F
     v  = v - v            3384          4800            No
      FO   F   R
     v                     314           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                3698          4600                   No
      12                                                                        !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L  =   28.9    pc/mi/ln
                       R              12         D
Level of service for ramp-freeway junction areas of influence D

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                D  = 0.456
                                             S
Space mean speed in ramp influence area,    S  = 57.2    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 57.2    mph
________________________________________________________________________________
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Phone:                                      Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Waverly Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           2870           vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              600            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2870        600                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 797         167                  v
Trucks and buses                        12          2                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.943       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3380        687                   pcph

_________________________Estimation of V12 Merge Areas___________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  2028   pc/h
                   12   F   FM

______________________________Capacity Checks____________________________________

                           Actual        Maximum         LOS F?
     v                     4067          7200            No
      FO
     v     v               1352 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                2028          4400                   No
      12                                                                        !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L  =   21.3    pc/mi/ln
                              R            12           A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                M  = 0.324
                                             S
Space mean speed in ramp influence area,    S  = 60.9    mph
                                             R
Space mean speed in outer lanes,            S  = 66.9    mph
                                             0
Space mean speed for all vehicles,          S  = 62.8    mph
________________________________________________________________________________
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                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Diverge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0           mph
Volume on freeway                         3470           vph

________________________________Off Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0           mph
Volume on ramp                            420            vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                  vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                      Freeway     Ramp        Adjacent
                                                                 Ramp
Volume, V (vph)                          3470        420                  vph
Peak-hour factor, PHF                    0.90        0.90
Peak 15-min volume, v15                  964         117                  v
Trucks and buses                         11          2                    %
Recreational vehicles                    0           0                    %
Terrain type:                            Level       Rolling
    Grade                                0.00    %   0.00    %            %
    Length                               0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                 1.5*        2.5
Recreational vehicle PCE, ER             1.2*        2.0
Heavy vehicle adjustment, fHV            0.948       0.971
Driver population factor, fP             1.00        1.00
Flow rate, vp                            4068        481                   pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.636   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  2763   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                             Actual        Maximum         LOS F?
     v  = v                  4068          7200            No
      Fi   F
     v  = v - v              3587          7200            No
      FO   F   R
     v                       481           2000            No
      R
     v     v                 1305 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?            No
      3 or  av34
Is   v     v       > 1.5 v  /2             No
      3 or  av34          12
If yes, v    =                             (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                        Actual        Max Desirable          Violation?
     v                  2763          4600                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density,            D = 4.252 + 0.0086 v  - 0.009  L   =   20.8    pc/mi/ln
                                         R            12        D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                 D  = 0.471
                                              S
Space mean speed in ramp influence area,     S  = 56.8    mph
                                              R
Space mean speed in outer lanes,             S  = 75.6    mph
                                              0
Space mean speed for all vehicles,           S  = 61.7    mph
______________________________________________________________________________
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                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Merge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0           mph
Volume on freeway                         3050           vph

_________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0           mph
Volume on ramp                            1520           vph
Length of first accel/decel lane          800            ft
Length of second accel/decel lane                        ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                  vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                      Freeway     Ramp        Adjacent
                                                                 Ramp
Volume, V (vph)                          3050        1520                 vph
Peak-hour factor, PHF                    0.90        0.90
Peak 15-min volume, v15                  847         422                  v
Trucks and buses                         11          2                    %
Recreational vehicles                    0           0                    %
Terrain type:                            Level       Rolling
    Grade                                        %           %            %
    Length                                       mi          mi           mi
Trucks and buses PCE, ET                 1.5*        2.5
Recreational vehicle PCE, ER             1.2*        2.0
Heavy vehicle adjustment, fHV            0.948       0.971
Driver population factor, fP             1.00        1.00
Flow rate, vp                            3575        1740                  pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  2145   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                             Actual        Maximum         LOS F?
     v                       5315          7200            No
      FO
     v     v                 1430 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?            No
      3 or  av34
Is   v     v       > 1.5 v  /2             No
      3 or  av34          12
If yes, v    =                             (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area_____________________
                        Actual        Max Desirable          Violation?
     v                  2145          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   30.0    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  D

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                 M  = 0.455
                                              S
Space mean speed in ramp influence area,     S  = 57.3    mph
                                              R
Space mean speed in outer lanes,             S  = 66.7    mph
                                              0
Space mean speed for all vehicles,           S  = 59.5    mph
______________________________________________________________________________
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2030 Wellsville North Alternative - AM Peak Hour - HCS Freeway Ramps

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                      HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                  Fax:
E-mail:

_________________________________Diverge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           4570           vph

_________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              900            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         4570        900                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 1269        250                  v
Trucks and buses                        9           4                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00     %           %
     Length                             0.00    mi  0.00     mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.957       0.943
Driver population factor, fP            1.00        1.00
Flow rate, vp                           5306        1060                     pcph

________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.579   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  3517   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v  = v                5306          7200            No
      Fi   F
     v  = v - v            4246          7200            No
      FO   F   R
     v                     1060          2000            No
      R
     v     v               1789 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                3517          4600                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density,            D = 4.252 + 0.0086 v  - 0.009  L   =   27.3    pc/mi/ln
                                        R           12        D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                 D  = 0.523
                                              S
Space mean speed in ramp influence area,     S  = 55.3     mph
                                              R
Space mean speed in outer lanes,             S  = 73.7     mph
                                              0
Space mean speed for all vehicles,           S  = 60.4     mph
______________________________________________________________________________
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Phone:                                  Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               8 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data___________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           5340           vph

__________________________________On Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              550            vph
Length of first accel/decel lane            1000           ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)_______________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions_____________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         5340        550                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 1483        153                  v
Trucks and buses                        9           2                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %            %           %
     Length                                     mi           mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.957       0.971
Driver population factor, fP            1.00        1.00
Flow rate, vp                           6200        629                      pcph

________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.605   Using Equation  1
                   FM
                  v  = v  (P  ) =  3754   pc/h
                   12   F   FM

______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v                     6829          7200            No
      FO
     v     v               2446 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                3754          4400                   No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   33.1    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  D

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                 M  = 0.563
                                              S
Space mean speed in ramp influence area,     S  = 54.2     mph
                                              R
Space mean speed in outer lanes,             S  = 62.6     mph
                                              0
Space mean speed for all vehicles,           S  = 57.0     mph
______________________________________________________________________________
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Phone:                                    Fax:
E-mail:

_________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               9 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                          Merge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0          mph
Volume on freeway                         3670          vph

__________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            1670          vph
Length of first accel/decel lane          500           ft
Length of second accel/decel lane                       ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp       Adjacent
                                                             Ramp
Volume, V (vph)                       3670        1670                vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               1019        464                 v
Trucks and buses                      9           2                   %
Recreational vehicles                 0           0                   %
Terrain type:                         Level       Rolling
     Grade                                    %          %            %
     Length                                   mi         mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
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Heavy vehicle adjustment, fHV          0.957       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          4261        1911                    pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.591   Using Equation  1
                   FM
                  v  = v  (P  ) =  2520   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     6172          7200            No
      FO
     v     v               1741 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2520          4400                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   36.0    pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  E

_____________________________Speed Estimation__________________________________

Intermediate speed variable,               M  = 0.614
                                            S
Space mean speed in ramp influence area,   S  = 52.8    mph
                                            R
Space mean speed in outer lanes,           S  = 65.5    mph
                                            0
Space mean speed for all vehicles,         S  = 55.9    mph
_______________________________________________________________________________
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Phone:                                    Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data_________________________________

Type of analysis                          Diverge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0          mph
Volume on freeway                         3610          vph

_________________________________Off Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   2
Free-Flow speed on ramp                   45.0          mph
Volume on ramp                            1610          vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane         500           ft

_________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp       Adjacent
                                                             Ramp
Volume, V (vph)                       3610        1610                vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               1003        447                 v
Trucks and buses                      12          3                   %
Recreational vehicles                 0           0                   %
Terrain type:                         Level       Rolling
     Grade                            0.00    %   0.00   %            %
     Length                           0.00    mi  0.00   mi           mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

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Heavy vehicle adjustment, fHV          0.943       0.957
Driver population factor, fP           1.00        1.00
Flow rate, vp                          4252        1869                    pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.450   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2941   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                4252          7200            No
      Fi   F
     v  = v - v            2383          7200            No
      FO   F   R
     v                     1869          4100            No
      R
     v     v               1311 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2941          4600                   No
      12                                                                       !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   10.6    pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,               D  = 0.466
                                            S
Space mean speed in ramp influence area,   S  = 56.9    mph
                                            R
Space mean speed in outer lanes,           S  = 75.6    mph
                                            0
Space mean speed for all vehicles,         S  = 61.6    mph
_______________________________________________________________________________
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2030 Wellsville North Alternative - AM Peak Hour - HCS Freeway Ramps

```
                 HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                               Fax:
E-mail:

_________________________________Merge Analysis__________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2000          vph

__________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              430           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway    Ramp       Adjacent
                                                              Ramp
Volume, V (vph)                         2000       430                  vph
Peak-hour factor, PHF                   0.90       0.90
Peak 15-min volume, v15                 556        119                  v
Trucks and buses                        12         7                    %
Recreational vehicles                   0          0                    %
Terrain type:                           Level      Rolling
     Grade                                     %          %          %
     Length                                    mi         mi         mi
Trucks and buses PCE, ET                1.5*       2.5
Recreational vehicle PCE, ER            1.2*       2.0
Heavy vehicle adjustment, fHV           0.943      0.905
Driver population factor, fP            1.00       1.00
Flow rate, vp                           2356       528                  pcph

________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1413   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     2884          7200            No
      FO
     v     v               943  pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1413          4400                   No
      12                                                                   !
________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   15.4    pc/mi/ln
          R                   R          12            A
Level of service for ramp-freeway junction areas of influence  B

____________________________Speed Estimation___________________________________

Intermediate speed variable,                  M  = 0.292
                                               S
Space mean speed in ramp influence area,      S  = 61.8    mph
                                               R
Space mean speed in outer lanes,              S  = 68.4    mph
                                               0
Space mean speed for all vehicles,            S  = 63.8    mph
_______________________________________________________________________________
```

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                 HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                               Fax:
E-mail:

________________________________Diverge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2430          vph

________________________________Off Ramp Data___________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              830           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway    Ramp       Adjacent
                                                              Ramp
Volume, V (vph)                         2430       830                  vph
Peak-hour factor, PHF                   0.90       0.90
Peak 15-min volume, v15                 675        231                  v
Trucks and buses                        17         7                    %
Recreational vehicles                   0          0                    %
Terrain type:                           Level      Rolling
     Grade                              0.00   %   0.00   %          %
     Length                             0.00   mi  0.00   mi         mi
Trucks and buses PCE, ET                1.5*       2.5
Recreational vehicle PCE, ER            1.2*       2.0
Heavy vehicle adjustment, fHV           0.922      0.905
Driver population factor, fP            1.00       1.00
Flow rate, vp                           2930       1019                 pcph

________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.640   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  2242   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                2930          7200            No
      Fi   F
     v  = v - v            1911          7200            No
      FO   F   R
     v                     1019          2000            No
      R
     v     v               688  pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34           12
If yes, v    =                           (Equation 25-18)
         12A

_____________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                2242          4600                   No
      12                                                                   !
________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   16.3    pc/mi/ln
                       R                 12           D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation___________________________________

Intermediate speed variable,                  D  = 0.520
                                               S
Space mean speed in ramp influence area,      S  = 55.4    mph
                                               R
Space mean speed in outer lanes,              S  = 76.8    mph
                                               0
Space mean speed for all vehicles,            S  = 59.3    mph
_______________________________________________________________________________
```

2030 Wellsville North Alternative - AM Peak Hour - HCS Freeway Ramps

```
                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Merge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1600          vph

_________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            190           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

___________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1600        190                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               444         53                   v
Trucks and buses                      17          3                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
    Grade                                     %           %           %
    Length                                    mi          mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.922       0.957
Driver population factor, fP          1.00        1.00
Flow rate, vp                         1929        221                  pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1157   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v                     2150          7200            No
      FO
     v     v               772  pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1157          4400                   No
      12                                                                    !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   11.1    pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  B

____________________________Speed Estimation__________________________________

Intermediate speed variable,                M  = 0.280
                                             S
Space mean speed in ramp influence area,    S  = 62.1    mph
                                             R
Space mean speed in outer lanes,            S  = 69.0    mph
                                             0
Space mean speed for all vehicles,          S  = 64.5    mph
______________________________________________________________________________
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                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               14 Waverly Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Diverge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0          mph
Volume on freeway                         1790          vph

________________________________Off Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            470           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

___________________Conversion to pc/h Under Base Conditions___________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       1790        470                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               497         131                  v
Trucks and buses                      19          2                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
    Grade                             0.00    %   0.00    %           %
    Length                            0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.913       0.971
Driver population factor, fP          1.00        1.00
Flow rate, vp                         2178        538                  pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.681   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  1655   pc/h
                   12   R      F   R   FD

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v  = v                2178          7200            No
      Fi   F
     v  = v - v            1640          7200            No
      FO   F   R
     v                     538           2000            No
      R
     v     v               523  pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                1655          4600                   No
      12                                                                    !
________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   11.3    pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation__________________________________

Intermediate speed variable,                D  = 0.476
                                             S
Space mean speed in ramp influence area,    S  = 56.7    mph
                                             R
Space mean speed in outer lanes,            S  = 76.8    mph
                                             0
Space mean speed for all vehicles,          S  = 60.5    mph
______________________________________________________________________________
```

2030 Wellsville North Alternative - PM Peak Hour - HCS Freeway Ramps

HCS+: Ramps and Ramp Junctions Release 5.21

Phone: Fax:
E-mail:

Merge Analysis

Analyst: Tom Hiles
Agency/Co.: HDR Inc.
Date performed: 4/2/2008 9:27:05 AM
Analysis time period: AM
Freeway/Dir of Travel: I-35 Southbound
Junction: 15 Waverly Entr
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1320	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	120	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	1320		120			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	367		33			v
Trucks and buses	19		3			%
Recreational vehicles	0		0			%
Terrain type:	Level		Rolling			
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5*		2.5			
Recreational vehicle PCE, ER	1.2*		2.0			
Heavy vehicle adjustment, fHV	0.913		0.957			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	1606		139			pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1606 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1745	4800	No
v_{3} or v_{av34}	0 pc/h	(Equation 25-4 or 25-5)	
Is v_{3} or v_{av34} > 2700 pc/h?		No	
Is v_{3} or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} =		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1606	4400	No

!

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 14.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.287	
Space mean speed in ramp influence area,	S_R = 62.0	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 62.0	mph

HCS+: Ramps and Ramp Junctions Release 5.21

Phone: Fax:
E-mail:

Diverge Analysis

Analyst: Tom Hiles
Agency/Co.: HDR Inc.
Date performed: 4/2/2008 9:27:05 AM
Analysis time period: AM
Freeway/Dir of Travel: I-35 Southbound
Junction: 16 Sunflower Exit
Jurisdiction: KDOT
Analysis Year: 2030
Description: NEPA Traffic Study

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1440	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	340	vph
Length of first accel/decel lane	800	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	1440		340			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	400		94			v
Trucks and buses	24		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Rolling			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5*		2.5			
Recreational vehicle PCE, ER	1.2*		2.0			
Heavy vehicle adjustment, fHV	0.893		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	1792		378			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 1792 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	1792	4800	No
$v_{FO} = v_F - v_R$	1414	4800	No
v_R	378	2000	No
v_{3} or v_{av34}	0 pc/h	(Equation 25-15 or 25-16)	
Is v_{3} or v_{av34} > 2700 pc/h?		No	
Is v_{3} or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} =		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1792	4600	No

!

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ = 12.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	D_S = 0.462	
Space mean speed in ramp influence area,	S_R = 57.1	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 57.1	mph

2030 Wellsville North Alternative - PM Peak Hour - HCS Freeway Ramps

HCS+: Ramps and Ramp Junctions Release 5.21

Phone: Fax:
E-mail:

```
_______________________________Merge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   AM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               17 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_______________________________Freeway Data_______________________________

Type of analysis                         Merge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0          mph
Volume on freeway                        1110          vph

_______________________________On Ramp Data_______________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-flow speed on ramp                  35.0          mph
Volume on ramp                           95            vph
Length of first accel/decel lane         800           ft
Length of second accel/decel lane                      ft

_________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                No
Volume on adjacent Ramp                                vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                              ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                 Freeway    Ramp       Adjacent
                                                          Ramp
Volume, V (vph)                     1110       95                  vph
Peak-hour factor, PHF               0.90       0.90
Peak 15-min volume, v15             308        26                  v
Trucks and buses                    24         7                   %
Recreational vehicles               0          0                   %
Terrain type:                       Level      Rolling
     Grade                                 %          %          %
     Length                                mi         mi         mi
Trucks and buses PCE, ET            1.5*       2.5
Recreational vehicle PCE, ER        1.2*       2.0
Heavy vehicle adjustment, fHV       0.893      0.905
Driver population factor, fP        1.00       1.00
Flow rate, vp                       1381       117                 pcph

_________________________Estimation of V12 Merge Areas_______________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1381   pc/h
                   12   F   FM

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1498          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v        > 2700 pc/h?         No
      3 or  av34
Is   v     v        > 1.5 v  /2          No
      3 or  av34            12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                1381          4400                  No
      12                                                                    !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   12.1    pc/mi/ln
                              R             12           A
Level of service for ramp-freeway junction areas of influence  B

____________________________Speed Estimation__________________________________

Intermediate speed variable,              M  = 0.282
                                           S
Space mean speed in ramp influence area,  S  = 62.1    mph
                                           R
Space mean speed in outer lanes,          S  =  N/A    mph
                                           0
Space mean speed for all vehicles,        S  = 62.1    mph
______________________________________________________________________________
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2030 Wellsville North Alternative - PM Peak Hour - HCS Freeway Ramps

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                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               1 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1370          vph

________________________________Off Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              95            vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1370        95                    vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 381         26                    v
Trucks and buses                        22          8                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %             %
     Length                             0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.901       0.893
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1690        118                   pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =             (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1690   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v  = v                1690          4800            No
      Fi   F
     v  = v - v            1572          4800            No
      FO   F   R
     v                     118           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                       Actual        Max Desirable         Violation?
     v                 1690          4600                  No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   11.6    pc/mi/ln
                          R                 12          D
Level of service for ramp-freeway junction areas of influence B

______________________________Speed Estimation________________________________

Intermediate speed variable,                  D  = 0.439
                                               S
Space mean speed in ramp influence area,      S  = 57.7    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 57.7    mph
______________________________________________________________________________
```

```
                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               2 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           1275          vph

_________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              430           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1275        430                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 354         119                   v
Trucks and buses                        22          0                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                                      %           %             %
     Length                                     mi          mi            mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.901       1.000
Driver population factor, fP            1.00        1.00
Flow rate, vp                           1573        478                   pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1573   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                           Actual        Maximum         LOS F?
     v                     2051          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area_____________________
                       Actual        Max Desirable         Violation?
     v                 1573          4400                  No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   16.2    pc/mi/ln
              R               R          12          A
Level of service for ramp-freeway junction areas of influence  B

______________________________Speed Estimation________________________________

Intermediate speed variable,                  M  = 0.295
                                               S
Space mean speed in ramp influence area,      S  = 61.7    mph
                                               R
Space mean speed in outer lanes,              S  =  N/A    mph
                                               0
Space mean speed for all vehicles,            S  = 61.7    mph
______________________________________________________________________________
```

2030 Wellsville North Alternative - PM Peak Hour - HCS Freeway Ramps

```
                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               3 Waverly Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1700           vph

________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              110            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1700        110                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 472         31                   v
Trucks and buses                        0           4                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
    Grade                               0.00    %   0.00     %           %
    Length                              0.00    mi  0.00     mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          1.000       0.943
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1889        130                    pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1889   pc/h
                   12   R     F   R   FD

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1889          4800            No
      Fi   F
     v  = v - v            1759          4800            No
      FO   F   R
     v                     130           2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable           Violation?
     v                1889          4600                    No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   13.3    pc/mi/ln
                          R                  12         D
Level of service for ramp-freeway junction areas of influence B

____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.440
                                              S
Space mean speed in ramp influence area,     S  = 57.7     mph
                                              R
Space mean speed in outer lanes,             S  =  N/A     mph
                                              0
Space mean speed for all vehicles,           S  = 57.7     mph
_______________________________________________________________________________
```

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                     HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               4 Waverly Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1590           vph

_________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              520            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1590        520                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 442         144                  v
Trucks and buses                        0           2                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
    Grade                                       %            %           %
    Length                                      mi           mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          1.000       0.971
Driver population factor, fP           1.00        1.00
Flow rate, vp                          1767        595                    pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1060   pc/h
                   12   F   FM

______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2362          7200            No
      FO
     v     v               707  pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable           Violation?
     v                1060          4400                    No
      12                                                                      !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   13.1    pc/mi/ln
                              R           12            A
Level of service for ramp-freeway junction areas of influence  B

____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.285
                                              S
Space mean speed in ramp influence area,     S  = 62.0     mph
                                              R
Space mean speed in outer lanes,             S  = 69.3     mph
                                              0
Space mean speed for all vehicles,           S  = 64.0     mph
_______________________________________________________________________________
```

2030 Wellsville North Alternative - PM Peak Hour - HCS Freeway Ramps

```
                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Diverge Analysis_______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               5 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           2110           vph

________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0           mph
Volume on ramp                              210            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                    vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                  ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2110        210                  vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 586         58                   v
Trucks and buses                        21          5                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                              0.00    %   0.00    %            %
     Length                             0.00    mi  0.00    mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.905       0.930
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2591        251                  pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =           (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.684   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  1851   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                             Actual        Maximum         LOS F?
     v  = v                  2591          7200            No
      Fi   F
     v  = v - v              2340          7200            No
      FO   F   R
     v                       251           2000            No
      R
     v     v                 740  pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?            No
      3 or  av34
Is   v     v       > 1.5 v  /2             No
      3 or  av34          12
If yes, v    =                             (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                        Actual        Max Desirable          Violation?
     v                  1851          4600                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density,            D = 4.252 + 0.0086 v  - 0.009  L   =   13.0    pc/mi/ln
                         R                  12      D
Level of service for ramp-freeway junction areas of influence B

_______________________________Speed Estimation________________________________

Intermediate speed variable,                 D  = 0.451
                                              S
Space mean speed in ramp influence area,     S  = 57.4    mph
                                              R
Space mean speed in outer lanes,             S  = 76.8    mph
                                              0
Space mean speed for all vehicles,           S  = 61.8    mph
_______________________________________________________________________________
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________________________________Merge Analysis_________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               6 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           1900           vph

_________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              1010           vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         1900        1010                 vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 528         281                  v
Trucks and buses                        21          4                    %
Recreational vehicles                   0           0                    %
Terrain type:                           Level       Rolling
     Grade                                      %           %            %
     Length                                     mi          mi           mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
Heavy vehicle adjustment, fHV           0.905       0.943
Driver population factor, fP            1.00        1.00
Flow rate, vp                           2333        1190                 pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =           (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  1400   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                             Actual        Maximum         LOS F?
     v                       3523          7200            No
      FO
     v     v                 933  pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?            No
      3 or  av34
Is   v     v       > 1.5 v  /2             No
      3 or  av34          12
If yes, v    =                             (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area____________________
                        Actual        Max Desirable          Violation?
     v                  1400          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   20.1    pc/mi/ln
                              R            12            A
Level of service for ramp-freeway junction areas of influence  C

_______________________________Speed Estimation________________________________

Intermediate speed variable,                 M  = 0.317
                                              S
Space mean speed in ramp influence area,     S  = 61.1    mph
                                              R
Space mean speed in outer lanes,             S  = 68.4    mph
                                              0
Space mean speed for all vehicles,           S  = 62.9    mph
_______________________________________________________________________________
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2030 Wellsville North Alternative - PM Peak Hour - HCS Freeway Ramps

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_________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               7 US-56 Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Diverge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           2910          vph

_________________________________Off Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-Flow speed on ramp                     35.0          mph
Volume on ramp                              500           vph
Length of first accel/decel lane            800           ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent ramp                                   vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2910        500                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 808         139                   v
Trucks and buses                        17          9                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
    Grade                               0.00    %   0.00    %             %
    Length                              0.00    mi  0.00    mi            mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
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Heavy vehicle adjustment, fHV           0.922       0.881
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3508        631                       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.643   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  2482   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v  = v                3508          7200            No
      Fi   F
     v  = v - v            2877          7200            No
      FO   F   R
     v                     631           2000            No
      R
     v     v               1026 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual       Max Desirable         Violation?
     v                2482         4600                  No
      12                                                                     !
_________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   18.4    pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence B

_______________________________Speed Estimation_________________________________

Intermediate speed variable,                D  = 0.485
                                             S
Space mean speed in ramp influence area,    S  = 56.4    mph
                                             R
Space mean speed in outer lanes,            S  = 76.7    mph
                                             0
Space mean speed for all vehicles,          S  = 61.2    mph
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_________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               8 US-56 Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data__________________________________

Type of analysis                            Merge
Number of lanes in freeway                  3
Free-flow speed on freeway                  70.0          mph
Volume on freeway                           3760          vph

__________________________________On Ramp Data__________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0          mph
Volume on ramp                              580           vph
Length of first accel/decel lane            1000          ft
Length of second accel/decel lane                         ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                   vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                 ft

____________________Conversion to pc/h Under Base Conditions___________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         3760        580                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 1044        161                   v
Trucks and buses                        17          3                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
    Grade                                       %           %             %
    Length                                      mi          mi            mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
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Heavy vehicle adjustment, fHV           0.922       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           4533        673                       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.605   Using Equation  1
                   FM
                  v  = v  (P  ) =  2745   pc/h
                   12   F   FM

_______________________________Capacity Checks__________________________________

                           Actual        Maximum         LOS F?
     v                     5206          7200            No
      FO
     v     v               1788 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v   =                            (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area______________________
                      Actual       Max Desirable         Violation?
     v                2745         4400                  No
      12                                                                     !
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   25.6    pc/mi/ln
          R                   R            12           A
Level of service for ramp-freeway junction areas of influence  C

_______________________________Speed Estimation_________________________________

Intermediate speed variable,                M  = 0.370
                                             S
Space mean speed in ramp influence area,    S  = 59.6    mph
                                             R
Space mean speed in outer lanes,            S  = 65.4    mph
                                             0
Space mean speed for all vehicles,          S  = 61.5    mph
________________________________________________________________________________
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2030 Wellsville North Alternative - PM Peak Hour - HCS Freeway Ramps

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                    HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                   Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Northbound
Junction:               9 Loop Ramp Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Merge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0         mph
Volume on freeway                         2410         vph

_________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0         mph
Volume on ramp                            1350         vph
Length of first accel/decel lane          500          ft
Length of second accel/decel lane                      ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                              ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp       Adjacent
                                                             Ramp
Volume, V (vph)                       2410        1350                 vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               669         375                  v
Trucks and buses                      17          3                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
    Grade                                   %           %           %
    Length                                  mi          mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.922       0.957
Driver population factor, fP          1.00        1.00
Flow rate, vp                         2905        1568                 pcph

_________________________Estimation of V12 Merge Areas________________________

                  L   =            (Equation 25-2 or 25-3)
                   EQ
                  P   =    0.591   Using Equation  1
                   FM
                  v  = v  (P  ) =  1718   pc/h
                   12   F   FM

_______________________________Capacity Checks________________________________

                            Actual        Maximum         LOS F?
     v                      4473          7200            No
      FO
     v     v                1187 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?           No
      3 or  av34
Is   v     v       > 1.5 v  /2            No
      3 or  av34          12
If yes, v    =                            (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                1718          4400                  No
      12                                                                     !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   27.2    pc/mi/ln
          R                   R           12           A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation_________________________________

Intermediate speed variable,               M  = 0.390
                                            S
Space mean speed in ramp influence area,   S  = 59.1    mph
                                            R
Space mean speed in outer lanes,           S  = 67.5    mph
                                            0
Space mean speed for all vehicles,         S  = 61.1    mph
_______________________________________________________________________________
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E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               10 US 56 Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Diverge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0         mph
Volume on freeway                         5620         vph

________________________________Off Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   2
Free-Flow speed on ramp                   45.0         mph
Volume on ramp                            1730         vph
Length of first accel/decel lane          800          ft
Length of second accel/decel lane         500          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                              ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp       Adjacent
                                                             Ramp
Volume, V (vph)                       5620        1730                 vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               1561        481                  v
Trucks and buses                      10          2                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
    Grade                             0.00    %   0.00    %           %
    Length                            0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
Heavy vehicle adjustment, fHV         0.952       0.971
Driver population factor, fP          1.00        1.00
Flow rate, vp                         6557        1980                 pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L   =            (Equation 25-8 or 25-9)
                   EQ
                  P   =    0.450   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  4040   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks________________________________

                            Actual        Maximum         LOS F?
     v  = v                 6557          7200            No
      Fi   F
     v  = v - v             4577          7200            No
      FO   F   R
     v                      1980          4100            No
      R
     v     v                2517 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?           No
      3 or  av34
Is   v     v       > 1.5 v  /2            No
      3 or  av34          12
If yes, v    =                            (Equation 25-18)
         12A

_____________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                4040          4600                  No
      12                                                                     !
________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   20.1    pc/mi/ln
                        R                   12         D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation_________________________________

Intermediate speed variable,               D  = 0.476
                                            S
Space mean speed in ramp influence area,   S  = 56.7    mph
                                            R
Space mean speed in outer lanes,           S  = 70.9    mph
                                            0
Space mean speed for all vehicles,         S  = 61.4    mph
_______________________________________________________________________________
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2030 Wellsville North Alternative - PM Peak Hour - HCS Freeway Ramps

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                HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                 Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               11 US 56 Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                       Merge
Number of lanes in freeway             3
Free-flow speed on freeway             70.0           mph
Volume on freeway                      3890           vph

_________________________________On Ramp Data_________________________________

Side of freeway                        Right
Number of lanes in ramp                1
Free-flow speed on ramp                35.0           mph
Volume on ramp                         940            vph
Length of first accel/decel lane       800            ft
Length of second accel/decel lane                     ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?              No
Volume on adjacent Ramp                               vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                             ft

___________________Conversion to pc/h Under Base Conditions__________________

Junction Components                 Freeway     Ramp        Adjacent
                                                            Ramp
Volume, V (vph)                     3890        940                   vph
Peak-hour factor, PHF               0.90        0.90
Peak 15-min volume, v15             1081        261                   v
Trucks and buses                    10          4                     %
Recreational vehicles               0           0                     %
Terrain type:                       Level       Rolling
    Grade                                   %           %           %
    Length                                  mi          mi          mi
Trucks and buses PCE, ET            1.5*        2.5
Recreational vehicle PCE, ER        1.2*        2.0
Heavy vehicle adjustment, fHV       0.952       0.943
Driver population factor, fP        1.00        1.00
Flow rate, vp                       4538        1107                  pcph

_________________________Estimation of V12 Merge Areas________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  2722   pc/h
                   12   F   FM
______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     5645          7200            No
      FO
     v     v               1816 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                2722          4400                   No
      12                                                                     !
________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   29.8    pc/mi/ln
          R                  R           12            A
Level of service for ramp-freeway junction areas of influence  D

____________________________Speed Estimation__________________________________

Intermediate speed variable,                M  = 0.444
                                             S
Space mean speed in ramp influence area,    S  = 57.6    mph
                                             R
Space mean speed in outer lanes,            S  = 65.3    mph
                                             0
Space mean speed for all vehicles,          S  = 59.8    mph
_______________________________________________________________________________
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                HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                 Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               12 Gardner Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                       Diverge
Number of lanes in freeway             3
Free-flow speed on freeway             70.0           mph
Volume on freeway                      4830           vph

________________________________Off Ramp Data_________________________________

Side of freeway                        Right
Number of lanes in ramp                1
Free-Flow speed on ramp                35.0           mph
Volume on ramp                         1610           vph
Length of first accel/decel lane       800            ft
Length of second accel/decel lane                     ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?              No
Volume on adjacent ramp                               vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                             ft

___________________Conversion to pc/h Under Base Conditions__________________

Junction Components                 Freeway     Ramp        Adjacent
                                                            Ramp
Volume, V (vph)                     4830        1610                  vph
Peak-hour factor, PHF               0.90        0.90
Peak 15-min volume, v15             1342        447                   v
Trucks and buses                    12          3                     %
Recreational vehicles               0           0                     %
Terrain type:                       Level       Rolling
    Grade                           0.00    %   0.00    %           %
    Length                          0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET            1.5*        2.5
Recreational vehicle PCE, ER        1.2*        2.0
Heavy vehicle adjustment, fHV       0.943       0.957
Driver population factor, fP        1.00        1.00
Flow rate, vp                       5689        1869                  pcph

_________________________Estimation of V12 Diverge Areas______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.532   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  3900   pc/h
                   12   R      F   R   FD
______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                5689          7200            No
      Fi   F
     v  = v - v            3820          7200            No
      FO   F   R
     v                     1869          2000            No
      R
     v     v               1789 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area___________________
                      Actual        Max Desirable          Violation?
     v                3900          4600                   No
      12                                                                     !
________________Level of Service Determination (if not F)_____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   30.6    pc/mi/ln
                        R                12          D
Level of service for ramp-freeway junction areas of influence D

____________________________Speed Estimation__________________________________

Intermediate speed variable,                D  = 0.596
                                             S
Space mean speed in ramp influence area,    S  = 53.3    mph
                                             R
Space mean speed in outer lanes,            S  = 73.7    mph
                                             0
Space mean speed for all vehicles,          S  = 58.4    mph
_______________________________________________________________________________
```

2030 Wellsville North Alternative - PM Peak Hour - HCS Freeway Ramps

```
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Phone:                                    Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               13 Gardner Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Merge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0          mph
Volume on freeway                         3220          vph

_________________________________On Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-flow speed on ramp                   35.0          mph
Volume on ramp                            400           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       3220        400                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               894         111                  v
Trucks and buses                      12          4                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
    Grade                                     %           %           %
    Length                                    mi          mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.943       0.943
Driver population factor, fP          1.00        1.00
Flow rate, vp                         3792        471                  pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    0.600   Using Equation  1
                   FM
                  v  = v  (P  ) =  2275   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                          Actual        Maximum        LOS F?
     v                    4263          7200           No
      FO
     v     v              1517 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?          No
      3 or  av34
Is   v     v      > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                          (Equation 25-8)
         12A

______________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                2275          4400                  No
      12                                                                    !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   21.7    pc/mi/ln
          R                   R            12            A
Level of service for ramp-freeway junction areas of influence  C

___________________________Speed Estimation__________________________________

Intermediate speed variable,              M  = 0.326
                                           S
Space mean speed in ramp influence area,  S  = 60.9    mph
                                           R
Space mean speed in outer lanes,          S  = 66.3    mph
                                           0
Space mean speed for all vehicles,        S  = 62.7    mph
______________________________________________________________________________
```

```
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Phone:                                    Fax:
E-mail:

________________________________Diverge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               14 Waverly Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                          Diverge
Number of lanes in freeway                3
Free-flow speed on freeway                70.0          mph
Volume on freeway                         3620          vph

________________________________Off Ramp Data_________________________________

Side of freeway                           Right
Number of lanes in ramp                   1
Free-Flow speed on ramp                   35.0          mph
Volume on ramp                            610           vph
Length of first accel/decel lane          800           ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                 No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                   Freeway     Ramp        Adjacent
                                                              Ramp
Volume, V (vph)                       3620        610                  vph
Peak-hour factor, PHF                 0.90        0.90
Peak 15-min volume, v15               1006        169                  v
Trucks and buses                      15          2                    %
Recreational vehicles                 0           0                    %
Terrain type:                         Level       Rolling
    Grade                             0.00    %   0.00    %           %
    Length                            0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET              1.5*        2.5
Recreational vehicle PCE, ER          1.2*        2.0
```

```
Heavy vehicle adjustment, fHV         0.930       0.971
Driver population factor, fP          1.00        1.00
Flow rate, vp                         4324        698                  pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    0.620   Using Equation  5
                   FD
                  v  = v  + (v - v ) P  =  2945   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_______________________________

                          Actual        Maximum        LOS F?
     v  = v               4324          7200           No
      Fi   F
     v  = v - v           3626          7200           No
      FO   F   R
     v                    698           2000           No
      R
     v     v              1379 pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?          No
      3 or  av34
Is   v     v      > 1.5 v  /2           No
      3 or  av34         12
If yes, v    =                          (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable         Violation?
     v                2945          4600                  No
      12                                                                    !
_________________Level of Service Determination (if not F)____________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   22.4    pc/mi/ln
                        R                 12          D
Level of service for ramp-freeway junction areas of influence C

___________________________Speed Estimation__________________________________

Intermediate speed variable,              D  = 0.491
                                           S
Space mean speed in ramp influence area,  S  = 56.3    mph
                                           R
Space mean speed in outer lanes,          S  = 75.3    mph
                                           0
Space mean speed for all vehicles,        S  = 61.2    mph
______________________________________________________________________________
```

2030 Wellsville North Alternative - PM Peak Hour - HCS Freeway Ramps

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                      HCS+: Ramps and Ramp Junctions Release 5.21




Phone:                                   Fax:
E-mail:

_________________________________Merge Analysis______________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               15 Waverly Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                         Merge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0           mph
Volume on freeway                        3010           vph

__________________________________On Ramp Data_______________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-flow speed on ramp                  35.0           mph
Volume on ramp                           350            vph
Length of first accel/decel lane         800            ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                No
Volume on adjacent Ramp                                 vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                               ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                 Freeway     Ramp        Adjacent
                                                            Ramp
Volume, V (vph)                     3010        350                   vph
Peak-hour factor, PHF               0.90        0.90
Peak 15-min volume, v15             836         97                    v
Trucks and buses                    15          3                     %
Recreational vehicles               0           0                     %
Terrain type:                       Level       Rolling
     Grade                                  %           %           %
     Length                                 mi          mi          mi
Trucks and buses PCE, ET            1.5*        2.5
Recreational vehicle PCE, ER        1.2*        2.0
Heavy vehicle adjustment, fHV           0.930       0.957
Driver population factor, fP            1.00        1.00
Flow rate, vp                           3595        406                     pcph

_________________________Estimation of V12 Merge Areas_______________________

                  L  =            (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  3595   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     4001          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

_______________________Flow Entering Merge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                3595          4400                   No
      12                                                                    !
_________________Level of Service Determination (if not F)___________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   31.5    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  D

_____________________________Speed Estimation________________________________

Intermediate speed variable,                M  = 0.478
                                             S
Space mean speed in ramp influence area,    S  = 56.6    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 56.6    mph
_____________________________________________________________________________
```

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Phone:                                   Fax:
E-mail:

_________________________________Diverge Analysis____________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               16 Sunflower Exit
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

__________________________________Freeway Data_______________________________

Type of analysis                         Diverge
Number of lanes in freeway               2
Free-flow speed on freeway               70.0           mph
Volume on freeway                        3360           vph

_________________________________Off Ramp Data_______________________________

Side of freeway                          Right
Number of lanes in ramp                  1
Free-Flow speed on ramp                  35.0           mph
Volume on ramp                           850            vph
Length of first accel/decel lane         800            ft
Length of second accel/decel lane                       ft

________________________Adjacent Ramp Data (if one exists)___________________

Does adjacent ramp exist?                No
Volume on adjacent ramp                                 vph
Position of adjacent ramp
Type of adjacent ramp
Distance to adjacent ramp                               ft

____________________Conversion to pc/h Under Base Conditions_________________

Junction Components                 Freeway     Ramp        Adjacent
                                                            Ramp
Volume, V (vph)                     3360        850                   vph
Peak-hour factor, PHF               0.90        0.90
Peak 15-min volume, v15             933         236                   v
Trucks and buses                    16          23                    %
Recreational vehicles               0           0                     %
Terrain type:                       Level       Rolling
     Grade                          0.00    %   0.00    %           %
     Length                         0.00    mi  0.00    mi          mi
Trucks and buses PCE, ET            1.5*        2.5
Recreational vehicle PCE, ER        1.2*        2.0
Heavy vehicle adjustment, fHV           0.926       0.743
Driver population factor, fP            1.00        1.00
Flow rate, vp                           4032        1270                    pcph

_________________________Estimation of V12 Diverge Areas_____________________

                  L  =            (Equation 25-8 or 25-9)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  4032   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v  = v                4032          4800            No
      Fi   F
     v  = v - v            2762          4800            No
      FO   F   R
     v                     1270          2000            No
      R
     v     v               0    pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-18)
         12A

_____________________Flow Entering Diverge Influence Area____________________
                      Actual        Max Desirable          Violation?
     v                4032          4600                   No
      12                                                                    !
_________________Level of Service Determination (if not F)___________________

Density,              D = 4.252 + 0.0086 v  - 0.009  L   =   31.7    pc/mi/ln
                       R                  12          D
Level of service for ramp-freeway junction areas of influence D

_____________________________Speed Estimation________________________________

Intermediate speed variable,                D  = 0.542
                                             S
Space mean speed in ramp influence area,    S  = 54.8    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 54.8    mph
_____________________________________________________________________________
```

2030 Wellsville North Alternative - PM Peak Hour - HCS Freeway Ramps

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                   HCS+: Ramps and Ramp Junctions Release 5.21



Phone:                                      Fax:
E-mail:

________________________________Merge Analysis________________________________

Analyst:                Tom Hiles
Agency/Co.:             HDR Inc.
Date performed:         4/2/2008 9:27:05 AM
Analysis time period:   PM
Freeway/Dir of Travel:  I-35 Southbound
Junction:               17 Sunflower Entr
Jurisdiction:           KDOT
Analysis Year:          2030
Description:  NEPA Traffic Study

_________________________________Freeway Data_________________________________

Type of analysis                            Merge
Number of lanes in freeway                  2
Free-flow speed on freeway                  70.0           mph
Volume on freeway                           2510           vph

_________________________________On Ramp Data_________________________________

Side of freeway                             Right
Number of lanes in ramp                     1
Free-flow speed on ramp                     35.0           mph
Volume on ramp                              190            vph
Length of first accel/decel lane            800            ft
Length of second accel/decel lane                          ft

________________________Adjacent Ramp Data (if one exists)____________________

Does adjacent ramp exist?                   No
Volume on adjacent Ramp                                    vph
Position of adjacent Ramp
Type of adjacent Ramp
Distance to adjacent Ramp                                  ft

____________________Conversion to pc/h Under Base Conditions__________________

Junction Components                     Freeway     Ramp        Adjacent
                                                                Ramp
Volume, V (vph)                         2510        190                   vph
Peak-hour factor, PHF                   0.90        0.90
Peak 15-min volume, v15                 697         53                    v
Trucks and buses                        16          6                     %
Recreational vehicles                   0           0                     %
Terrain type:                           Level       Rolling
     Grade                                      %           %           %
     Length                                     mi          mi          mi
Trucks and buses PCE, ET                1.5*        2.5
Recreational vehicle PCE, ER            1.2*        2.0
```

```
Heavy vehicle adjustment, fHV          0.926       0.917
Driver population factor, fP           1.00        1.00
Flow rate, vp                          3012        230                   pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 25-2 or 25-3)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  3012   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     3242          4800            No
      FO
     v     v               0    pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v    =                           (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                3012          4400                   No
      12                                                                     !
_________________Level of Service Determination (if not F)____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   25.6    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                 M  = 0.365
                                              S
Space mean speed in ramp influence area,     S  = 59.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 59.8    mph
________________________________________________________________________________
```

HDR

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Attachments from Comment Letter R116

BNSF NOVEMBER 13, 2012
COMMENT LETTER
RE SCIG RDEIR

ATTACHMENT C

Diesel Emissions and Lung Cancer:

Epidemiology and Quantitative Risk Assessment

A Special Report of the Institute's Diesel Epidemiology Expert Panel

Health Effects Institute

June 1999

HEI HEALTH EFFECTS INSTITUTE

The Health Effects Institute, established in 1980, is an independent and unbiased source of information on the health effects of motor vehicle emissions. HEI supports research on all major pollutants, including regulated pollutants (such as carbon monoxide, ozone, nitrogen dioxide, and particulate matter), and unregulated pollutants (such as diesel engine exhaust, methanol, and aldehydes). To date, HEI has supported more than 200 projects at institutions in North America and Europe and published over 100 Research Reports. Consistent with its mission to serve as an independent source of information on the health effects of motor vehicle pollutants, the Institute also engages in special review and evaluation activities.

Typically, HEI receives half its funds from the U.S. Environmental Protection Agency and half from 28 manufacturers and marketers of motor vehicles and engines in the United States. Occasionally, funds from other public or private organizations either support special projects or provide resources for a portion of an HEI study. Regardless of funding sources, HEI exercises complete autonomy in setting its research priorities and in reaching its conclusions. An independent Board of Directors governs HEI. The Institute's Research and Review Committees serve complementary scientific purposes and draw distinguished scientists as members. The results of HEI-funded research and evaluations have been used in public and private decision-making.

Statement from the HEI Board of Directors

Diesel engine technology has played a valuable role in the transportation industry worldwide since the Second World War. Diesel-powered engines are more efficient than gasoline-powered engines, and as a result they emit less carbon dioxide, which is a greenhouse gas. However, diesel engine emissions contain more oxides of nitrogen, which are ozone precursors, and particulate matter than gasoline engine emissions. The impact on human health of inhaling particulate matter, especially in the development of lung cancer, has been a matter of scientific concern and research.

For more than a decade, state, national, and international agencies have spent considerable effort to examine the resulting scientific literature to determine whether diesel engine emissions, and more specifically, diesel particulate matter, is carcinogenic in humans. The majority of the effort has been focused on lung cancer. Regulatory agencies that have a mandate to protect the public's health have examined the biologic, toxicologic, and epidemiologic data to identify the possible carcinogenic hazard from exposure to diesel exhaust and to develop quantitative risk estimates for diesel exhaust exposure and lung cancer. These risk estimates have been controversial.

The Health Effects Institute has supported research on the health effects of exposure to diesel emissions for many years. In the early 1980s, this research, via studies of mutagenicity, metabolism, and carcinogenesis, focused on the organic constituents of diesel exhaust particles. In the late 1980s, a major study compared the carcinogenicity of diesel particles and carbon black in rats, and found very similar results: The carbonaceous particles, not the organic chemicals adsorbed onto the particles, were responsible for the tumor response in rats, which was most likely due to particles overloading the lung clearance mechanism.

In 1995, HEI published a Special Report, *Diesel Exhaust: A Critical Analysis of Emissions, Exposure, and Health Effects*, in which the HEI Diesel Working Group raised questions about the use of animal data for quantitative risk assessment. With respect to epidemiologic studies, the Working Group noted those studies showed consistent, small increases in risk for exposed workers, but concluded that the absence of concurrent exposure measurements limited the utility of those studies for quantitative risk assessment.

As part of the Institute's continued interest in diesel engine emissions and health effects, and in an effort to understand how current research or possible new research could be useful for quantitative risk assessment, HEI initiated the Diesel Epidemiology Project in 1998. This multifaceted effort includes the work of the Diesel Epidemiology Expert Panel (contained in this report), a set of feasibility studies to inform the direction of new research, and the Diesel Workshop: Building a Research Strategy to Improve Risk Assessment, held in March of 1999.

We appointed seven scientific experts in biostatistics, epidemiology, exposure assessment, and exposure characterization as the Diesel Epidemiology Expert Panel to examine specifically the strengths and limitations of the published epidemiologic studies currently available for quantitative risk estimation, and to evaluate discrepancies in the exposure-response findings reported. We have reviewed the report, and the process the Panel used in preparing it, and believe it presents a systematic and fair evaluation of the available epidemiologic studies and the associated quantitative data. The Panel also has identified through its analysis a reasonable explanation for conflicting exposure-response findings previously reported.

We expect that the Panel's review, analyses, and recommendations will be used by HEI and others to address research priorities for further quantitative estimation of the relation between exposure to diesel emissions and lung cancer risk. We also note the need to consider the relation between diesel emissions and noncancer health effects. As the use of diesel fuels around the world expands to take advantage of fuel economy and reduced greenhouse gas emissions, the full range of health effects needs to be considered and weighed along with potential climate change benefits.

In addition to thanking the entire HEI Diesel Epidemiology Expert Panel, we would particularly like to thank Dr. John C. Bailar III, Chair of the Panel, and Dr. Diane J. Mundt, who served as HEI's scientific project manager.

Archibald Cox, *Chairman*

Douglas Costle	Susan B. King
Alice Huang	Richard B. Stewart
Donald Kennedy	Robert M. White

Diesel Emissions and Lung Cancer: Epidemiology and Quantitative Risk Assessment

A Special Report of the Institute's Diesel Epidemiology Expert Panel

Contributors to the Project

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This report was submitted for outside peer review. The Health Effects Institute appreciates the thoughtful critiques provided by the reviewers listed below. The views expressed in this report are those of the Diesel Epidemiology Expert Panel and no endorsement by the external reviewers should be inferred.

The Panel extends its gratitude to Aaron Blair, William Bunn, Glen Cass, James Cogliano, Kenny Crump, Stanley Dawson, Eric Garshick, Dale Hattis, Daniel Krewski, Philip Lorang, Frank Mirer, Suresh Moolgavkar, Robert O'Keefe, Jonathan Samet, Michael Spallek, Kyle Steenland, Duncan Thomas, Gerald van Belle, Jane Warren, and Winthrop Watts.

Although this document was produced with partial funding by the United States Environmental Protection Agency under Assistance Agreement 824835 to the Health Effects Institute, it has not been subjected to the Agency's peer and administrative review and therefore may not necessarily reflect the views of the Agency, and no official endorsement should be inferred. The contents of this document also have not been reviewed by private party institutions, including those that support the Health Effects Institute; therefore, it may not reflect the views and policies of those parties, and no endorsement by them should be inferred.

Executive Summary

Diesel engines are an important part of the world's transportation and industrial infrastructure, especially in heavy-duty applications such as trucks, buses, construction and farm equipment, locomotives, and ships. Energy efficiency and durability account for the dominant use of diesel engines worldwide, and their use may expand in the future. In Europe, 20% to 50% of the new light-duty passenger fleet is powered by diesel engines. Although the percentage of diesel-powered light-duty vehicles is much lower in the United States, advanced technology diesel engines are being proposed as part of the nation's energy conservation and climate change strategies.

The economic advantages of diesel engines are clear; nevertheless, environmental concerns and related health issues must be addressed. Emissions from all types of engines are highly variable and complex mixtures. Diesel engines are more efficient than gasoline engines, and they emit less carbon dioxide (a greenhouse gas), carbon monoxide, and hydrocarbons. Therefore, diesel engines have some advantages over conventional gasoline engines in terms of global warming. However, they emit higher levels of oxides of nitrogen, which are ozone precursors, and particulate matter per vehicle mile traveled than do gasoline engines. The particulates are of special concern in possible health outcomes; they are small enough to be readily respirable, and they have many chemicals adsorbed to their surfaces, including known or suspected mutagens and carcinogens.

Cellular, animal, and human studies have investigated the association between exposure to diesel exhaust and adverse health effects, including cancer. Lung tumors have occurred in rats exposed to diesel exhaust, but the relevance of these lesions to human risk assessment has been questioned. Epidemiologic studies fairly consistently show an elevation in lung cancer rates among occupationally exposed individuals. In most studies, rates are 20% to 50% greater than those in unexposed individuals; however, these studies did not obtain quantitative measurements of exposure during the time period of the study.

Although epidemiologic data have been used generally to identify the hazards associated with exposure to diesel exhaust, questions remain as to whether the human data can be used to develop reliable estimates of the magnitude of any risk for lung cancer (that is, through quantitative risk assessment [QRA]), and whether new research efforts could provide any additional data needed. In response to such issues, the Health Effects Institute initiated the Diesel Epidemiology Project in 1998. The Project includes the evaluation by HEI's Diesel Epidemiology Expert Panel of occupational epidemiologic studies that have been used for QRA, and the development of new research initiatives to improve understanding about the health effects of diesel exhaust.

The Diesel Epidemiology Expert Panel was chaired by John C. Bailar, III, M.D., Ph.D., of The University of Chicago and the HEI Review Committee, and included six other scientists who have expertise in epidemiology, biostatistics, exposure characterization, and exposure assessment. It was charged to (1) review the epidemiologic data that form the basis of current QRAs for diesel exhaust, (2) identify data gaps and sources of uncertainty, (3) make recommendations about the usefulness of extending or conducting further analyses of existing data sets, and (4) make recommendations for the design of new studies that would provide a stronger basis for risk assessment.

Although lung cancer was the health outcome of interest to the Panel's charge, it was not charged to evaluate either the broad toxicologic or epidemiologic literature concerning exposure to diesel exhaust and lung cancer for hazard identification purposes, which has been done by others. State, national, and international agencies have all reviewed the broader animal and human evidence for carcinogenicity and, in either their draft or final reports, have all identified diesel exhaust as a probable human carcinogen or placed it in a comparable category (National Institute for Occupational Safety and Health 1988; International Agency for Research on Cancer 1989; World Health Organization 1996; National Toxicology Program 1998; Office of Environmental Health Hazard Assessment [California Environmental Protection Agency] 1998; U.S. Environmental Protection Agency 1998).

In response to the first charge, the Panel examined published epidemiologic studies of diesel exhaust emissions and lung cancer for possible use in support of QRA. Only two such studies reported any quantitative exposure data associated in some manner with the occupational epidemiologic studies, and they were considered in the Panel's review.

The Panel recognized that no epidemiologic study can be perfect. Therefore, the Panel viewed its task as addressing the question: To what extent can limitations in the design and performance of a particular study affect its contribution to the body of epidemiologic knowledge under examination for QRA? The Panel also recognized that frequently it is very difficult to obtain retrospective data for estimating job-related work exposures, and that this process may require assumptions that cannot be validated. In the studies considered here, which form the core of the Panel's review, reasonable attempts were made to reconstruct past exposures to diesel engine emissions using approaches that were feasible when the studies were conducted. These data subsequently have been used, in some cases, for purposes that were not envisioned by the original investigators. The studies reviewed for this report include:

Railroad Worker Studies

- Case-control: Garshick et al. 1987
- Cohort: Garshick et al. 1988
- Industrial hygiene: Hammond 1988, and Woskie et al. 1988a,b
- Exposure-response analyses: Crump et al. 1991, Office of Environmental Health Hazard Assessment 1998, and Crump 1999

Teamster Studies

- Case-control: Steenland et al. 1990, 1992
- Industrial hygiene: Zaebst et al. 1991
- Exposure-response analysis: Steenland et al. 1998

The reports of these studies were supplemented by published articles and by presentations to the Panel by the principal investigators and others, including secondary analysts of the railroad worker data. The Panel did not consider other completed lung cancer and diesel epidemiologic studies because they included no directly associated quantitative exposure data.

Certain strengths are evident in the studies reviewed by the Panel. The epidemiologic studies include large numbers of study subjects (55,407 subjects, and 1,694 lung cancers, for the railroad worker cohort study; 1,256 deaths from lung cancer for the railroad worker case-control study; and 996 deaths from lung cancer for the teamster case-control study), all of whom were employed in industries where many workers are exposed to diesel exhaust. Job categories with known exposure to asbestos were either excluded or controlled for in the analyses. Both of the case-control studies adjusted data analyses to control for cigarette smoking as a confounding variable. Overall, the results are generally consistent with findings of a weak association between lung cancer and exposure to diesel exhaust. However, published secondary analyses of exposure-response relations in the railroad worker cohort data produced conflicting results (Crump et al. 1991; Office of Environmental Health Hazard Assessment 1998).

Measurements from the industrial hygiene studies in general supported the job exposure categories used in the epidemiologic studies. The industrial hygiene studies measured different markers for diesel exhaust exposure—respirable-sized particles (RSP) for railroad workers and submicron-sized elemental carbon (EC_1) for teamsters. Although the RSP measures were adjusted for the environmental tobacco smoke component, EC_1 is more sensitive and specific to diesel exhaust than adjusted RSP.

In response to the second charge, the Panel developed a framework of general epidemiologic questions about study design, exposure assessment, outcome determination, and analysis. These are meant to help in systematically understanding and revealing the strengths and uncertainties of these studies. This framework was then used to evaluate the studies of railroad workers and teamsters. This process helped to address the third and fourth charges to the Panel, and to assist HEI in focusing its future research directions to inform apparent gaps for QRA.

The original findings of the cohort railroad worker study reported by Garshick and coworkers (1988) indicated a steadily increasing risk of lung cancer for exposed workers with increasing years of employment. This increase with duration of employment, however, was not supported in later, unpublished analyses (Garshick 1991). This increasing risk, plus the availability of some quantitative exposure data in railroad workers (Woskie et al. 1988a,b), prompted additional analyses to explore the exposure-response relation in these data (Crump et al. 1991; Office of Environmental Health Hazard Assessment 1994, 1998; Crump 1999). Crump and colleagues found a negative association between lung cancer risk and several measures of cumulative exposure; that is, risk decreased with increasing cumulative exposure. In contrast, the statistical models used by the Office of Environmental Health Hazard Assessment analysts, using the same data but different assumptions, showed a positive association in which risk increased with increasing cumulative exposure.

The Panel explored these apparent inconsistencies in the exposure-response relation to verify and obtain a better understanding of the previous analyses, and to help clarify differences. These issues are central to whether the railroad worker data can be useful in a QRA for lung cancer.

The Panel's data exploration demonstrated that within the three broad railroad job categories of train workers (e.g., engineers, conductors), shop workers (e.g., electricians, machinists), and clerks and signalmen, the relative risk of lung cancer decreased with increasing duration of employment, and this decrease was statistically significant for the clerks/signalmen and train workers. Although the relative risk decreased with increasing duration of employment, overall risks for train workers, within each duration of employment group, were higher than those for clerks and signalmen, and shop workers had intermediate risks (Figure 1).

These findings are not consistent with a steadily increasing association between cumulative diesel exposure and lung cancer risk. Furthermore, if the difference in risk between train workers and clerks/signalmen was due primarily to differences in exposure to diesel emissions, one would expect the relative risk for train workers compared with that for clerks and signalmen to be reduced or even eliminated after adjusting for exposure. In fact, adjustment for exposure increased this relative risk. Such a systematic pattern of decreasing risk with increasing exposure suggests that some form of bias is present in the data, which makes it difficult to determine the true nature of an exposure-response relation. Bias can result from uncontrolled confounding by cigarette smoking or by other occupational exposure, differential misclassification of exposures by job category, longer survival of "healthier" workers, or differential ascertainment of lung cancer as a cause of death.

Initial findings from the teamster case-control study (Steenland et al. 1990) showed an increased risk of lung cancer with increasing years of employment. The investigators published an exposure-response analysis for the teamster study (Steenland et al. 1998) after the Panel's work started, thus the evaluation of this set of studies was necessarily less extensive.

Reconstructing past exposures for which actual data are limited or nonexistent requires several assumptions. The Panel had concerns about several of the assumptions used by Steenland and colleagues in the exposure-response analysis of the teamster data. These concerns include (1) the data on 1990 emissions used to estimate past exposures to diesel exhaust may underestimate average exposures over a range of work histories, given that more recent data show higher emissions for that time; (2) the date assumed for dieselization in the trucking industry, which, if too early, may overestimate exposures; (3) the degree to which vehicle miles traveled accurately reflects actual exposure to diesel exhaust for various job groups, which may affect exposure estimates in either direction; (4) the possible effects of using various scenarios of emission levels to account for long fleet turnover times in the trucking industry; and (5) the difficulty in distinguishing truck driver exposures from background levels, because measured estimates are close. Also, among the assumptions Steenland and colleagues used, nondiesel sources of elemental carbon in ambient air, especially from gasoline engine emissions, were not considered.

The Panel also was concerned about the controls used in the case-control study. Lung and bladder cancers and motor vehicle accidents were excluded as control causes of death, and controls were selected from other causes. If those causes of death were associated with exposure to diesel emissions, smoking, or both, the study findings could be biased.

Important work is currently under way to study the health effects of exposure to diesel exhaust in nonmetal miners in Germany (Säverin et al. 1998) and in the United States (National Cancer Institute–National Institute for Occupational Safety and Health 1997). The Panel did not review these studies because they are still in progress. However, the Panel heard presentations from these investigators at the HEI Diesel Workshop: Building a Research Strategy to Improve Risk Assessment (HEI 1999) at Stone Mountain, GA, March 7–9, 1999. In particular, the National Cancer Institute–National Institute for Occupational Safety and Health study is large and appears to be well designed and comprehensive. It includes a cohort and nested case-control component, as well as extensive current measurements of exposure to diesel exhaust, detailed reconstruction of historical exposure, and bio-

Figure 1. Panel's analysis depicting consistently elevated risk of lung cancer for train workers compared with clerks for each time period, but decreasing risk by job category over duration of employment. See Appendix C for details.

marker development. These studies in progress are likely to inform hazard identification, exposure estimation, and exposure-response analyses, all components of risk assessment.

The Panel recognizes that regulatory decisions need to be made in spite of the limitations and uncertainties of the few studies with quantitative data currently available. The findings described here and the systematic evaluation of these and other studies are designed to inform the ongoing process and provide a means to weigh a study's strengths and limitations.

FINDINGS

GENERAL

Enhanced exposure and epidemiologic data and analyses are needed for the purposes of QRA; these might come from further exploration of existing studies or from new studies.

RAILROAD WORKER STUDIES

At present, the railroad worker cohort study (Garshick et al. 1988), though part of a larger body of hazard identification studies, has very limited utility for QRA of lifetime lung cancer risk from exposure to ambient levels of diesel exhaust for the following reasons.

- The various exposure-response analyses are limited by the scope and quality of currently available exposure data. Quantitative exposure data were not obtained during the cohort study period. Also, there is a paucity of qualitative data on individual exposures before 1959, and on the variation in exposure by railroad site, by season, and over time. The potential impact of concurrent exposures (for example, to grease, dust, other fumes, asbestos, and active and passive cigarette smoke) were not examined in depth. The diesel exhaust exposure data are suitable for a crude categorical measure of exposure by job category; but other measures, including duration of employment in a job category exposed to diesel exhaust, intensity of exposure concentration ($\mu g/m^3$), and lifetime exposure ($[\mu g/m^3]$-years), are not adequate to support quantitative exposure-response analyses.
- The Panel's analysis of the exposure-response association in the railroad worker data showed that the evidence for a positive association of lung cancer with cumulative exposure to diesel exhaust depends entirely on differences in risks among job categories. Train workers (with higher exposures) have higher risks compared with clerks (with low or no exposure). However, within all job categories, the relation of lung cancer risk to duration of employment is negative.
- Factors that might explain a negative association between duration of employment and lung cancer in these data include bias introduced by systematic differences in exposure misclassification among and within job categories; differentially incomplete ascertainment of lung cancer deaths by job category; lack of information on other occupational exposures and air pollutants; the presence of a healthy worker survivor effect; confounding by cigarette smoking; and analysis of relative risks rather than absolute risks. Also, in a case-control study, if causes of death among controls were associated with exposure to diesel exhaust, smoking, or both, the results could be biased.

TEAMSTER STUDIES

The investigators' analysis of the teamster data reported an exposure-response relation (Steenland et al. 1998) that may be useful for QRA; this relation will be better understood with further exploration of uncertainties and assumptions, particularly those relating to the reconstruction of past exposures and the selection of controls. Exposures of teamsters are more similar to ambient exposures of the public than are exposures of railroad workers, and the diesel exhaust to which teamsters are exposed comes from a source that is likely to be relevant to regulatory issues.

The Panel reviewed the teamster study without the benefit of additional analyses and interpretations, and its comments are not as detailed as those about the railroad worker studies. Understanding the teamster study will evolve with time; however, some conclusions can be drawn now.

- The set of teamster studies may provide reasonable estimates of worker exposure to diesel exhaust, but significant further evaluation and development are needed. The marker for diesel exhaust that was selected for study by Steenland and associates, EC_1, is more sensitive and specific than RSP adjusted for environmental tobacco smoke, but has several limitations (e.g., the contribution of diesel emissions to ambient EC_1 concentrations has not been constant over time). The industrial hygiene study, which was conducted after the period when workers in the case-control study were exposed, identified a range of exposures for various job categories, but did not consider (1) site-to-site variations, (2) seasonal variations, (3) concurrent exposures to other agents, (4) historical ambient particle concentrations, or (5) intra- and interindividual variability. The estimation of historical exposures needs to incorporate recent data on diesel emissions from vehicles in use, reassessment of when dieselization occurred, alternatives to estimating exposure by vehicle miles traveled, and historical regional ambient pollution data.

- The exposure-response relation reported in the teamster study increases in a linear manner. However, more can be learned from other analysts examining these data using different approaches.
- Neither a roster of the study population nor an alternative method of selecting controls to represent it was available to the researchers. It cannot be established with certainty whether the causes of death used for controls adequately represent the joint distribution of exposure to diesel exhaust and smoking in the case-control study. If smoking, or diesel exhaust exposure as determined by job category, or both were associated with causes of death used for controls, results could be biased.

RECOMMENDATIONS

The Panel's recommendations reflect its general understanding, as expressed in its framework for evaluating studies, of what constitute adequate data for QRA. They also reflect the preceding evaluation of the studies of railroad workers and teamsters. The Panel is aware that research currently in progress will respond to some of these research needs; however, results are not yet available, and it is not yet clear whether all of the proposed needs will be met.

COMPLETED STUDIES

1. The Panel recommends against using the current railroad worker data as the basis for QRA in ambient settings.
2. Further scrutiny of the teamster data, including estimation of uncertainty in both the exposure estimates and selection of controls, is recommended in order to improve the use of these data in QRA. Strengths of the teamster study include the relevance of exposure levels to the general population and the use of an exposure marker for diesel engine emissions that was an improvement over RSP. The teamster study exposure-response analysis is relatively new, and its further review and analysis by both the original investigators and others should be accelerated. Alternative retrospective exposure models need to be developed that use the alternative assumptions described above and in more detail in the body of the text.

NEEDS FOR NEW TECHNIQUES AND DATA

3. Better measures of exposure to constituents of diesel emissions, with careful attention to selection of the sample studied, are needed. Of particular importance are the selection and validation of a chemical marker of exposure to the complex mix of diesel exhaust emissions. Exposure models may include data from personal monitors, area monitors placed where diesel exposure is likely to occur, and current and historical data regarding emission sources. In any such modeling effort, the effects of environmental tobacco smoke should be removed as completely as possible.
4. Reliable estimates of past emissions and of factors affecting historical exposures in a range of settings are needed to improve the characterization of uncertainties, both quantitative and qualitative, in historical models of exposures.
5. Although biomarker technology was not available when the studies reviewed were conducted, appropriate, validated, and specific biomarkers of diesel exposures, health outcomes, and susceptibility are needed.

DESIGN NEEDS FOR NEW STUDIES OF EXPOSURE-RESPONSE ANALYSES

6. Exposures should be adequately and accurately characterized with respect to magnitude, frequency, and duration, rather than solely by duration of employment. Errors and uncertainties in exposure measurements should be quantified where possible; these should be fully reported to users, and taken into account in both power calculations and exposure-response analyses.
7. Cigarette smoking is a potent risk factor for lung cancer, and it must be controlled for in any study of risk factors for this disease. Smoking histories obtained for a cohort study subset that uses a case-control or case-cohort design will strengthen the interpretation of results.
8. The exposures considered should be close to levels of regulatory concern, including a range of exposures to provide a base for understanding the relation between exposure and health effects.

NEEDS FOR NEW STUDIES

A prospective epidemiologic study of the development of lung cancer in exposed and unexposed individuals could have many strengths. Information on confounders and exposures could be more complete than for a retrospective study, and many of the biases and uncertainties discussed in this report could be eliminated or reduced. These advantages, however, need to be weighed against the disadvantages, which include high costs and a long period of follow-up. Other study designs that include retrospective components are possible for a new epidemiologic study of lung cancer, but they are likely to include uncertainties and sources of bias that investigators will need to explore completely and acknowledge in their reporting.

9. The Panel recommends that a new, large, epidemiologic study of diesel exhaust emissions and lung cancer be considered after (1) currently ongoing or existing studies, including HEI's feasibility studies (to be completed in the spring of 2000), are evaluated, and (2) attempts to retrofit improved exposure assessments to existing epidemiologic studies are evaluated, including whether they can provide sufficiently accurate, complete, and relevant exposure data to support QRA.
10. Studies of lung cancer risk in general populations exposed to ambient diesel exhaust particulate matter will be difficult to conduct; however, such studies could usefully investigate other, noncancer health effects that occur in a shorter time after exposure.

Diesel Emissions and Lung Cancer: Epidemiology and Quantitative Risk Assessment

Background

Diesel engines are an important part of the world's transportation and industrial infrastructure, especially in heavy-duty machinery such as trucks, buses, construction and farm equipment, locomotives, and ships. The use of diesel engines may expand in the future because they are energy-efficient and durable.

In Europe, where fuel prices are three to four times higher than in the United States and concern for climate change is high, 20% to 50% of the new light-duty passenger fleet is powered by diesel engines. In 1996, 1.8% of the light-duty vehicles (passenger cars, light-duty trucks [up to 10,000 pounds gross vehicle weight], vans, and sport utility vehicles) sold in the U.S. were diesel-powered, almost all of which were light-duty trucks. Of all the light-duty trucks sold that year, about 3.7% were diesel-powered; whereas only about 0.1% of all passenger cars sold had diesel engines (Davis 1998). Advanced technology diesel engines are being proposed as key elements in the U.S. energy conservation strategy (e.g., for use in sport utility vehicles and in the Partnership for a New Generation of Vehicles' fuel-efficient car).

Although diesel engines have economic advantages, environmental issues must be considered. Emissions from all types of engines are highly variable and complex mixtures. Diesel engines are more efficient (per vehicle mile traveled) than gasoline engines and emit less carbon dioxide (a greenhouse gas), carbon monoxide, and hydrocarbons; however, they emit more oxides of nitrogen, which are ozone precursors, and particulate matter. It is difficult to estimate exposures to individual constituents of diesel engine emissions because the amount and concentration of each constituent depend on such factors as engine type, fuel, and operating conditions. Moreover, fuel reformulation and changes in engine technology have caused substantial changes in diesel emissions over time. In addition, it is challenging to distinguish diesel emission constituents in ambient air from other combustion products and cigarette smoke.

The particulates emitted in diesel exhaust are of special concern in possible health outcomes because (1) they are very small (less than 1 µm in size) and readily respirable, and (2) they have many chemicals adsorbed to their surfaces, including some known or suspected mutagens and carcinogens. Cellular, animal, and human studies have investigated the association between exposure to diesel exhaust and cancer and other diseases.

DIESEL EXHAUST AND LUNG CANCER

Scientists have conducted toxicologic and epidemiologic studies to examine the potential for diesel emissions to cause or contribute to the development of cancer and other diseases. Some studies have looked specifically at the particulate matter component of diesel emissions; others refer simply to "diesel exhaust." In this report, diesel particulate matter (DPM) is specified when applicable. Laboratory studies have established that lifelong exposures to high concentrations of DPM produce lung tumors (benign and malignant) in rats, equivocal results in mice, and no tumors in hamsters. The roles that high-dose exposure protocols and species-specific factors have in the induction of rat lung tumors by DPM have been investigated. (This material is reviewed in publications by HEI [1995], the World Health Organization [WHO] [1996], and the International Life Sciences Institute [ILSI] [1999]). Rats develop lung tumors (benign and malignant) when they are exposed to DPM at concentrations of 2,000 to 10,000 $\mu g/m^3$ for 35 hours or more each week over their lifetimes (HEI 1995). Prolonged exposure to high concentrations of a variety of other supposedly inert particulate materials also causes lung tumors in rats through a mechanism that involves impairment of lung clearance mechanisms (referred to as "lung overload response"). This impairment can lead to inflammation, cell proliferation, metaplasia, and ultimately the development of lung tumors (HEI 1995; ILSI 1999). The levels of DPM required to produce lung tumors in rats, however, are approximately three orders of magnitude higher than current estimates of average ambient (nonoccupational) concentrations of DPM. Because lung overload is not expected to occur in humans as a result of ambient or most occupational exposures to DPM, some organizations have suggested that the rat lung tumor response to high concentrations of particulate matter is not relevant for quantitative risk assessment (QRA) (HEI 1995; ILSI 1999).

More than 40 epidemiologic studies of workers have examined the association between exposure to diesel exhaust and the risk of lung cancer. Several review articles discuss this literature in depth (Cohen and Higgins 1995; WHO 1996; Boffetta 1997; Bhatia et al. 1998; Office of Health Hazard Assessment [OEHHA] 1998; U.S. Environmental Protection Agency [EPA] 1998). The epidemiologic studies generally show higher risks of lung cancer among persons occupationally exposed to diesel exhaust than among persons who have not been exposed, or who have been exposed to lower levels or for shorter periods of time. Occupational groups studied include railroad workers, truck drivers, bus garage workers, heavy equipment operators, dock workers, and underground miners. In these studies, the relative risk (RR), as a measure of association between exposure and lung cancer, generally has been between 1.2 and 1.5 (that is, an excess of 20% to 50% over the risk in unexposed persons); somewhat more variation in relative risk was reported among subgroups examined in individual studies. Some reviews critical of these data have cited study design flaws, including uncontrolled confounding and lack of exposure measures, leading to a lack of convincing evidence (Muscat and Wynder 1995; Stöber and Abel 1996; Morgan et al. 1997).

Two studies are under way to evaluate the association between exposure to diesel emissions and lung cancer among nonmetal miners in Germany (Säverin et al. 1998) and in the United States (National Cancer Institute–National Institute for Occupational Safety and Health [NCI-NIOSH] 1997). Some results of the former study are available now; those of the latter study are expected in about 2003.

RISK ASSESSMENTS OF DIESEL EMISSIONS

Several organizations have reviewed the relevant science, including the epidemiologic, toxicologic, and experimental studies of diesel engine exhaust, and have classified (or proposed to classify) the exhaust mixture, or the particulate component of the mixture, as a potential, probable, or definite human carcinogen (NIOSH 1988; International Agency for Research on Cancer [IARC] 1989; WHO 1996; OEHHA 1998; National Toxicology Program [NTP] 1998; U.S. EPA 1998). Each agency's current position on the carcinogenicity of diesel exhaust as cited in its draft or final report is as follows:

NIOSH (1988)

- Animal evidence "confirmatory" for carcinogenicity
- Human evidence "limited"
- Diesel exhaust classified as a "potential occupational carcinogen"
- No QRA

IARC (1989)

- Rat data "sufficient" for carcinogenicity
- Human epidemiologic data "limited"
- Diesel exhaust considered a "probable" human carcinogen
- No QRA

WHO (1996)

- Rat data support carcinogenicity
- Human epidemiologic data suggest "probably carcinogenic"
- Epidemiologic studies considered "inadequate for a quantitative estimate of human risk"
- Rat data used for QRA

California EPA (1998)

- Rat data "have demonstrated" carcinogenicity of diesel exhaust
- Causal association of diesel exhaust and lung cancer in epidemiologic studies is a "reasonable and likely explanation"
- Human epidemiologic data preferred for QRA because of uncertainties in rat data
- California Air Resources Board designated DPM a "toxic air contaminant"

NTP (1998 Draft)

- Committees have considered listing DPM as either "known to be a carcinogen" or "reasonably anticipated to be a carcinogen"
- Internal review complete; Directors' decision expected in 1999

U.S. EPA (1998 Draft)

- Rat experiments "adequate" for carcinogenicity
- Human epidemiologic studies "limited" evidence
- Diesel emissions considered "probable" human carcinogen
- Range of cancer risk estimates developed (on the basis of animal, epidemiologic, and comparative potency data)
- Revised risk assessment expected in 1999

In 1994, the U.S. EPA and the California EPA both released draft cancer risk assessments of diesel exhaust for public comment and review by scientific experts. Despite general agreement in their interpretation of the scientific literature, some important differences were apparent between the two reports. Most notably, the basis for the U.S. EPA's QRA was animal bioassay data because, in the view of the Agency's staff, the exposure data from human epidemiologic studies were too limited to support a QRA. In addition, the U.S. EPA staff, in conjunction with Dr. Kenny Crump, had tried to use data from a retrospective cohort study of U.S. railroad workers (Garshick et al. 1988) and an associated industrial hygiene survey (Hammond et al. 1988; Woskie et al. 1988a,b) to construct exposure-response estimates (Crump et al. 1991). Crump and colleagues did not find a positive exposure-response association for diesel exhaust and risk of lung cancer, however, and therefore concluded that it was not possible to use these data for a quantitative analysis.

In contrast, staff in the OEHHA of the California EPA, using the same railroad worker data, found an increasing exposure-response relationship (OEHHA 1994, 1998). Because of uncertainties in extrapolating from rat data to humans and the fact that some semiquantitative epidemiologic data were available, OEHHA determined that it was more appropriate to base risk assessment estimates for diesel exhaust on the epidemiologic data than on animal data.

The difference between these findings led HEI in 1996 to collaborate with the two agencies and others (NIOSH and WHO) to sponsor a scientific workshop, "Diesel Exhaust: Considerations in the Use of Epidemiologic Data for Quantitative Risk Assessments (QRA)," that focused on the strengths and limitations of the existing database. Participants discussed issues that underlie the differences in the exposure-response modeling of the railroad worker data. Although the findings were explored at length, workshop participants were unable to determine the reasons for the differences. The railroad worker data were the only epidemiologic data used in QRA until Steenland and colleagues (1998) published an exposure-response analysis of U.S. teamsters.

Questions still remain about how to develop a reliable QRA of diesel engine emissions and lung cancer. If the rat lung tumor data are not relevant for human cancer risk assessment, and if current epidemiologic studies do not provide the quantitative exposure measurements needed for exposure-response estimates, it is difficult to make informed decisions about possible health risks from exposure to diesel exhaust. Should existing epidemiologic studies be extended to include additional years of follow-up? Have diesel engines and fuels changed so much that studies of animals or humans exposed to diesel exhaust from old engines are no longer relevant? Government, industry, and the public have an interest in answers to these questions. HEI initiated its Diesel Epidemiology Project to help inform the decisions about appropriate ways to use the existing epidemiologic data and to suggest future research directions.

The HEI Diesel Epidemiology Project

In 1998, HEI initiated a multifaceted Diesel Epidemiology Project in response to the issues discussed in the Background chapter. This project includes the evaluation by HEI's Diesel Epidemiology Expert Panel of occupational epidemiologic studies that are currently being used for QRA, and the development of new research initiatives, including six feasibility studies to identify potential new cohorts to study or to improve exposure assessment estimates.

The Diesel Epidemiology Expert Panel (referred to here as "the Panel") was chaired by John C. Bailar III, M.D., Ph.D., of The University of Chicago and the HEI Health Review Committee, and included six other members (see Appendix A) with expertise in epidemiology, biostatistics, exposure characterization, and exposure assessment. Its charge was to (1) review the epidemiologic data that form the basis of current QRAs for diesel exhaust, (2) identify data gaps and sources of uncertainty, (3) make recommendations about the usefulness of extending or conducting further analyses of existing data sets, and (4) make recommendations for the design of new studies that would provide a stronger basis for risk assessment. The Panel was not charged to evaluate the broad epidemiologic literature concerning exposure to diesel exhaust and lung cancer for hazard identification purposes.

In response to the first charge, the Panel examined published epidemiologic studies for possible use in or contribution to QRA for diesel exhaust. However, quantitative exposure data were associated in some manner with only two epidemiologic studies, and those are considered in this report. Other diesel epidemiologic studies were not considered, because the lack of associated quantitative exposure data makes those studies less suitable for QRA. The studies forming the core of the Panel's review include:

Railroad Worker Studies

- Case-control: Garshick et al. 1987
- Cohort: Garshick et al. 1988
- Industrial hygiene: Hammond 1988, and Woskie et al. 1988a,b
- Exposure-response analyses: Crump et al. 1991, OEHHA 1998, and Crump 1999

Teamster Studies

- Case-control: Steenland et al. 1990, 1992
- Industrial hygiene: Zaebst et al. 1991
- Exposure-response analysis: Steenland et al. 1998

The Panel met on April 20–21, 1998, in Cambridge, MA, to hear presentations by the principal investigators of the epidemiologic studies listed above, and by the secondary analysts of the railroad worker cohort study. The Panel also began discussing how to approach its charge. An agenda for the workshop portion of the April 1998 meeting and a list of participants are in Appendix A. The Panel met in executive session on October 8–9, 1998; December 1, 1998; January 21, 1999; and by conference call on February 24 and April 9, 1999, to continue its work on this report.

At the first meeting of the Panel, inconsistent results of the exposure-response analysis of the railroad worker cohort data were presented by the secondary analysts. The Panel determined that it would need to explore the exposure-response relation in the original railroad worker data set in order to understand firsthand the reasons for the discrepancies. The Panel did not attempt to conduct its own exposure-response analysis for QRA. Eric Garshick, M.D., assisted the Panel by providing a copy of the original railroad worker data and documentation. Secondary analyst Stanley Dawson, Ph.D., of California EPA's OEHHA, provided documentation of his analysis of the original data set; likewise, Kenny Crump, Ph.D., provided the computer code listings he used for aggregating the original railroad worker data. The Panel is grateful to all these analysts for their cooperation and generosity in supporting this review.

THE PANEL'S APPROACH TO EVALUATING THE STUDIES

Epidemiologic studies of environmental pollutants and cancer are relevant to risk assessment, which includes some or all of the following steps: hazard identification (determination of whether or not an agent is causally linked to a health effect), exposure assessment (degree, timing, and level of exposure), dose-response assessment

Table 1. The Panel's Framework for Evaluating Epidemiologic Studies for Quantitative Risk Assessment

Element of Study		Questions for Evaluation
DESIGN	1.	Was the study design efficient, and did it specifically consider power, potential types of bias, and latency?
	2.	Were adequate quantitative exposure and covariate data planned and collected?
	3.	Was the literature reviewed for relevant study methods and previous research findings?
	4.	Were plans made for postpublication data scrutiny?
EXPOSURE ASSESSMENT	1.	Were detailed lifetime histories of occupational exposures collected?
	2.	Were known chemical and physical characteristics of the main exposure specified?
	3.	Were potentially confounding exposures measured or estimated?
	4.	Were magnitude, duration, and variability of exposure determined?
	5.	Were industrial hygiene data and historical data on use and repair of machinery and equipment obtained?
	6.	Were personal exposure measurements obtained, and were they representative of the population studied?
	7.	Were uncertainties in exposure assessment quantified?
OUTCOMES	1.	Were outcomes defined in specific and objective terms?
	2.	Was the full range of outcomes included in cohort studies?
	3.	Were participants actively followed to determine outcome status and the date outcome occurred?
ANALYSIS	1.	Were analytic methods specified a priori?
	2.	Was the appropriateness of the statistical approach demonstrated, and were potential biases explored?
	3.	Were exposure-response relations statistically explored?
	4.	Were uncertainties in risk estimates quantified, especially those resulting from exposure measurement error?

(determination of the relation between the magnitude of exposure and the health effect, including in subpopulations), and risk characterization (description of the nature and magnitude of risk, with uncertainties) (National Academy of Sciences 1983).

All of the characteristics that make a study relevant to hazard identification also help make a study relevant for QRA. But QRA requires more, including quantitative exposure data expressed in units that are comparable among the epidemiologic settings and the situations for which the risk estimates are desired. The quantitative data must be sufficient to construct an exposure-response curve on the basis of at least two levels of exposure. Occupational exposure levels often are much greater than ambient (nonoccupational) exposures. When occupational studies are used in a QRA that is to be extended to populations receiving ambient exposures, the analysts may need to extrapolate over a range from the high exposures observed to the lower exposures of interest; the closer the occupational exposures are to the ambient exposures of concern, the less extrapolation is required.

An important limitation of using most epidemiologic studies for QRA is the lack of adequate exposure data, especially historical information on exposure concentrations or rates. In retrospective studies, exposure assessment is almost always less than ideal; the problems and uncertainties in using such data need to be clearly acknowledged.

The Panel recognized that few, if any, studies are designed specifically for use in QRA. It determined that the most objective way to identify data gaps and sources of uncertainty was to systematically review the epidemiologic studies of railroad workers and teamsters*. To guide this process, the Panel developed a framework of general epidemiologic principles, described in Table 1.

This framework presents a series of questions about elements of study design, exposure assessment, outcome determination, and analysis that the Panel determined to be important for this evaluation. An affirmative answer to all questions is clearly unattainable for any epidemiologic study. The answers, however, not only highlight the strengths and limitations of each study, but also indicate where to focus additional or new research efforts. A rationale for including each of the items in the framework is detailed in Appendix B.

A draft version of this entire report was peer-reviewed by 18 external reviewers, including Drs. Garshick, Crump, and Dawson. All of the reviewer comments and concerns were considered and addressed as appropriate by the Panel. Preliminary, draft findings were presented by Panel members at HEI's Diesel Workshop: Building a Research Strategy to Improve Risk Assessment (1999), held at Stone Mountain, GA, March 7–9, 1999.

* The reference to "railroad worker study or studies" in the report refers specifically to the studies by Garshick and colleagues (1987, 1988) and, if appropriate, to the industrial hygiene studies by Woskie and associates (1988a,b) and Hammond (1988). The reference to "teamster study or studies" in the report is specific to the case-control study by Steenland and coworkers (1990), subsequent reports based on these data (Steenland et al. 1992, 1998) and, if appropriate, to the industrial hygiene study by Zaebst and associates (1991).

Summary of Railroad Worker and Teamster Studies

Two sets of studies widely cited as "key" or "important" epidemiologic investigations of diesel exhaust and lung cancer have been used for QRA. One set of studies includes cohort (Garshick et al. 1988) and case-control (Garshick et al. 1987) studies of railroad workers, industrial hygiene measures in railroad work sites (Woskie et al. 1988a,b; Hammond et al. 1988), and secondary exposure-response analyses of these data (Crump et al. 1991; OEHHA 1994, 1998; Crump 1999). The second set includes a case-control study of teamsters (Steenland et al. 1990, 1992), industrial hygiene measures in the trucking industry (Zaebst et al. 1991), and a recent exposure-response analysis (Steenland et al. 1998). This chapter briefly summarizes each study's methods and results.

RAILROAD WORKER STUDIES

Garshick and colleagues conducted both cohort (Garshick et al. 1988) and case-control (Garshick et al. 1987) studies of lung cancer deaths among U.S. railroad workers registered with the Railroad Retirement Board (RRB). The authors' background materials report that the U.S. railroad industry began introducing large numbers of diesel engines in about 1949; dieselization of the industry was essentially completed within 10 years. Figure 2 shows the transition from the use of steam (mostly coal-fired) to diesel locomotives over time (Railroad Facts 1940–1970). In both studies, Garshick and colleagues defined four diesel exhaust exposure groups: shop workers; engineers and firemen; brakemen, conductors, and hostlers; and unexposed (clerks and signalmen).

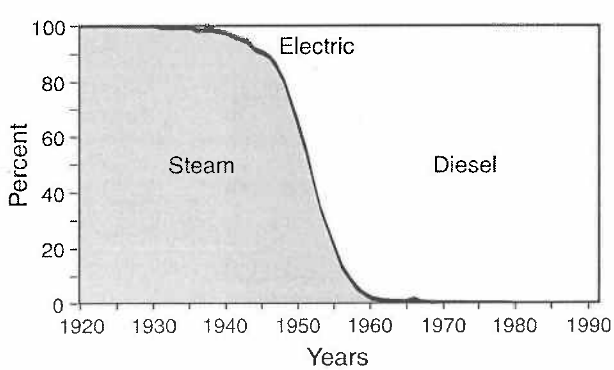

Figure 2. Percentage of trains powered by steam, electric, or diesel since 1920. (Data adapted from Railroad Facts 1940, 1944, 1946, 1948, 1950, 1953, 1954, 1957, 1964, 1967, 1970.)

COHORT STUDY

In the cohort study, Garshick and colleagues (1988) reported that they ascertained all deaths from 1959 to 1980 in a cohort of 55,407 white male railroad workers who had been actively employed and between 40 and 64 years of age in 1959, when nationwide conversion to diesel railway engines was nearly complete. Eligible subjects had begun work 10 to 20 years earlier (between 1939 and 1949), and in 1959, were employed in one of 39 jobs surveyed later in a companion industrial hygiene study (Woskie 1988a,b). Railroad Retirement Board records listed each person's job title, or titles, for each year starting in 1959. To reduce the potential for confounding by asbestos exposure, all workers whose jobs involved known exposure to asbestos (car repair and construction trade workers, and some trade workers in steam locomotive shops) were excluded from the cohort. Some shop workers and hostlers, not initially excluded, were also exposed to asbestos. Cigarette smoking information was not available for cohort members.

Fact of death was ascertained from the RRB through December 31, 1980. Among the 19,396 known deaths, 1,694 of the death certificates indicated lung cancer as a primary or contributing cause of death.

The investigators classified the workers' exposures according to the job held in 1959 or the cumulative years in an exposed job. Their analytic model including years of exposure to diesel exhaust (on the basis of duration of employment) and lung cancer showed an increase in risk of lung cancer with more years of exposure. The investigators also reported that 94% of the workers who were 40 to 44 years of age and working in a job exposed to diesel emissions in 1959 were still in an exposed job 20 years later. Unexposed workers also generally remained in their exposure category (97%). The relative risks for lung cancer and exposure to diesel exhaust on the basis of the job held in 1959 were inversely related to age in 1959; workers who were 40 to 44 years of age and working in a job category with exposure to diesel emissions in 1959 experienced an increase (RR = 1.5; 95% CI: 1.1, 1.9) in lung cancer mortality compared with those who were in that age category but held unexposed jobs in 1959. Excess relative risk of death from lung cancer declined as the worker's age in 1959 increased.

CASE-CONTROL STUDY

Garshick and colleagues (1987) also conducted a case-control study of RRB registrants who died between March 1, 1981, and February 28, 1982. Among 650,000 active and retired male railroad workers born in or after 1900 who had at least 10 years of railroad employment, 15,059 deaths were reported to the RRB. Cases consisted of all deaths for which primary lung cancer (International Classification of Disease, Version 8 [ICD 8] code 162) was indicated on the death certificate; this was the underlying cause of death in most cases. Investigators attempted to match each case with two deceased control subjects by age at death (within 2.5 years), and by date of death (within 31 days). Men who died from other cancers, suicides, accidents, or unknown causes were excluded as control subjects. The most common underlying causes of death among both older (age at death 65 years or older) and younger (age at death 64 years or younger) controls were diseases of the circulatory system (74% and 80%, respectively); deaths from nonmalignant respiratory disease also were included (15% of the older control subjects and 7% of younger controls). Overall, 1,256 lung cancer cases and 2,385 controls were considered in the analysis.

Exposure to diesel exhaust was assessed using (1) job histories beginning in 1959 for workers who retired after 1959, and (2) the last job worked before retirement for those who retired between 1955 and 1959. Each job was classified either as exposed or unexposed; cumulative exposure to diesel exhaust was summarized for each worker as diesel-years of exposure. Unlike the cohort study, the case-control study included persons who had worked in jobs other than the 39 jobs used to estimate diesel exhaust exposure levels in the industrial hygiene survey (Woskie et al. 1988a,b). These additional jobs were considered to be exposed or unexposed on the basis of (1) the similarity of job activities and work locations in question to jobs for which industrial hygiene samples had been taken, and (2) the extent of contact with operating diesel equipment that the job entailed.

Information on two potentially confounding variables (smoking and asbestos exposure) was collected. For smoking history, next of kin (usually a spouse) provided information on whether the subject had ever smoked; this information was obtained for 86% of cases and 82% of control subjects. If the age at which a worker began smoking was not available (which was true for less than 6% of both cases and controls), age 16 was assumed. Pack-years* of smoking history were missing for 22% of cases and 25% of controls. Asbestos exposure was ascertained from the work histories of those who retired after 1959 and from the last job held for those who retired between 1955 and 1959.

The investigators conducted separate analyses for younger workers (who died at or before age 64) and older workers (who died at age 65 or older), primarily because they reasoned that heavy cumulative exposure to diesel exhaust was more likely among the workers who died at a younger age. A second reason was attributed to a cited reference (Doll and Peto 1981) that indicated that the cause of death on a death certificate may be less accurate for workers who died at an older age. No excess risk of death from lung cancer in association with exposure to diesel exhaust was observed among the older workers. Among the younger workers, with diesel exposure modeled as a continuous variable, more than 20 years of exposure to diesel exhaust was associated with a crude RR = 1.4 (95% CI: 1.0, 1.8) for lung cancer mortality. Adjusting for asbestos and cigarette smoking had little effect on this estimate (RR = 1.4; 95% CI: 1.1, 1.9). Among younger workers, when years of diesel exposure were categorized (0–4, 5–19, 20+), an adjusted RR = 1.02 (95% CI: 0.72, 1.45) was found for workers with 5 to 19 years of diesel exposure, and an RR = 1.64 (95% CI: 1.18, 2.29) for those with 20 or more years of exposure, compared with the referent group with 0 to 4 years of diesel exposure.

INDUSTRIAL HYGIENE STUDIES OF RAILROAD WORKERS

Woskie and colleagues (1988a,b) conducted an industrial hygiene survey of U.S. railroad workers in four small northern railroads in the early 1980s to estimate occupational exposures to diesel exhaust. (This study was conducted during a time after the period when the workers in the epidemiologic studies would have been exposed.) They first identified 39 job titles (from among the more than 150 U.S. Interstate Commerce Commission railroad job titles) that encompassed large numbers of workers and that were thought to indicate either minimal or substantial exposure to diesel exhaust. These job titles were then collapsed into 13 job groups and, for some analyses, into 5 career exposure groups (clerks; signal maintainers; engineers and firers; brakers, conductors, and hostlers; and shop workers).

* Pack-years is the number of packs of cigarettes smoked per day times the number of years smoked.

The investigators developed three markers of diesel exhaust exposure: (1) the concentration of respirable-sized particles (RSP); (2) the adjusted respirable particle (ARP) concentration, which removed the particle contribution of environmental tobacco smoke (ETS) from the RSP; and (3) the adjusted extractable mass (AEM) (Hammond et al. 1988).

The RSP was the simplest marker to estimate in over 550 air samples from workers' breathing zones in 13 job groups at the four railroads, as well as in 23 air samples from fixed samplers in various railroad locations. Respirable matter (median aerodynamic diameter ≤ 3.5 µm) was collected on filters for analysis. Investigators also developed a method to collect and analyze nicotine from the same samples as a marker for ETS. The estimated ETS concentration was subtracted from the estimated RSP to obtain the second diesel marker, ARP. Dichloromethane was used to extract the organic chemical components of diesel exhaust, including the mutagens and carcinogens, from the RSP. The fraction of extractable material in the RSP was adjusted for the fraction of extractable ETS for the third index of exposure, AEM. Crump and colleagues (1991) used another index, total extractable material (TEX), which is the concentration of extractable RSP without the ETS fraction removed. None of these measures accounts for other respirable matter in the RSP, such as sand, dirt, or fibers.

The investigators used these data from four railroad yards to estimate a national career mean exposure for ARP (Woskie et al. 1988a,b). They used a linear statistical model to adjust for climate differences and variability of exposures among railroads across the country. This model included weighting factors to estimate the fraction of the year a railroad was in a "cold" (below 10°C) or "warm" (above 10°C) climate (Woskie et al. 1988b).

EXPOSURE-RESPONSE ANALYSES OF RAILROAD WORKERS

The railroad worker cohort study suggested that lung cancer risk increased with increasing cumulative years of exposure (Figure 3). Some quantitative exposure data were available for the industry as well. Because both types of information were available, analysts have used the data to develop exposure-response estimates for diesel emissions and lung cancer.

Crump and colleagues (1991) were the first to develop quantitative estimates of lung cancer risk associated with exposure to diesel exhaust by combining data from the railroad worker cohort study (Garshick et al. 1988) with exposure estimates from the industrial hygiene studies (Hammond et al. 1988; Woskie et al. 1988a,b). Crump and colleagues assigned average exposures as defined in the industrial hygiene studies to members of the railroad worker cohort, on the basis of yearly job codes beginning in 1959. They conducted analyses using RSP, ARP, AEM, and TEX estimates.

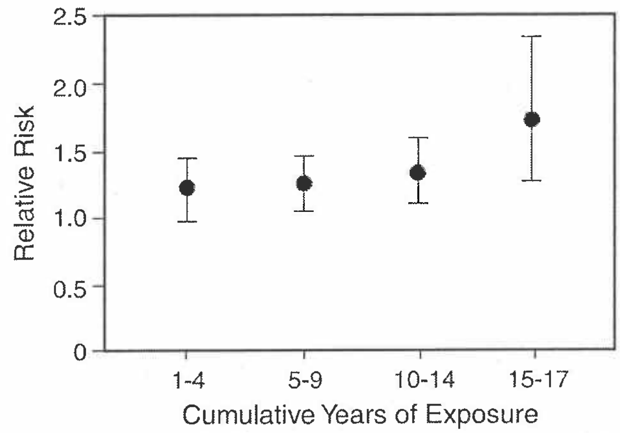

Figure 3. Relative risk of lung cancer by years of exposure to diesel exhaust in the railroad industry through 1980. Relative risk and 95% confidence intervals are shown. (Adapted from Figure 1 in Garshick et al. 1988.)

Crump and colleagues (1991) constructed several different exposure metrics that combined measures of particulate levels with information on regional climates for the U.S.; they used these metrics, plus age, calendar year, and five job categories (clerks; signal maintainers; engineers and firers; brakers, conductors, and hostlers; and shop workers) to conduct more than 50 analyses of the relation between exposure to diesel exhaust and death from lung cancer. All but two analytic models showed that subjects with the highest estimated cumulative exposures had the lowest risk of death from lung cancer (Figure 4).

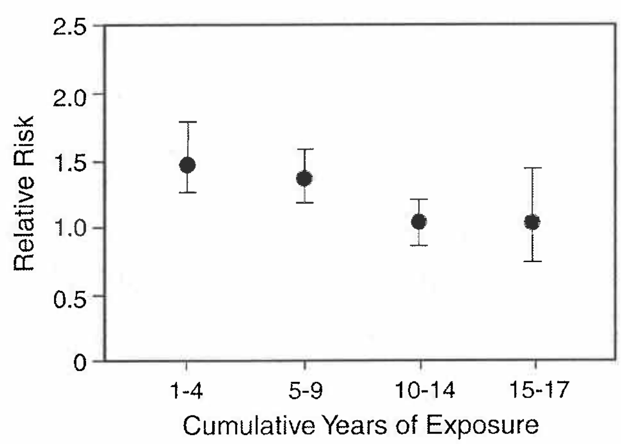

Figure 4. Relative risk of lung cancer by years of exposure to diesel exhaust in the railroad industry, using data from the cohort study. (Adapted from data presented in Crump et al. 1991.)

Crump and associates also discovered a limitation of the original cohort data. Whereas Garshick and colleagues (1988) had compared lung cancer mortality rates between exposed and unexposed railroad workers within the cohort, Crump and colleagues also compared the overall age- and year-specific death rates of the cohort to those rates in the U.S. population (Crump et al. 1991). This comparison suggested that follow-up (that is, determination of vital status) was incomplete between 1976 and 1980 as ascertained by the RRB. Garshick confirmed this, as noted in a letter to the U.S. EPA (Garshick 1991). This underascertainment of deaths from the RRB did not affect the major findings of Garshick and colleagues (1988) because Crump's analyses, limited to the years 1959 through 1976, revealed similar overall excess lung cancer mortality risk (Crump et al. 1991; Garshick 1991). In his letter, Garshick (1991) also presented a new analysis of lung cancer risk by years of diesel exposure, in which the data were modeled to allow the effect of age to vary in the cohort in a time-dependent manner between 1959 and 1980. Although the relative risks for all four exposure groupings were elevated, the estimated effect did not increase with increasing duration of exposure (Figure 5), in contrast to results Garshick had reported previously.

As part of the California EPA's risk assessment of diesel particulate matter, OEHHA analyzed exposure-response relations in the railroad worker data. The five job categories described were combined to form three exposure groups: exposed (engineers and firers; and brakers, conductors, and hostlers; collectively referred to as "train workers"), unexposed (clerks and signalmen), and uncertain (shop workers). Shop workers were excluded from some analyses because their exposure was assessed as uncertain (OEHHA 1998).

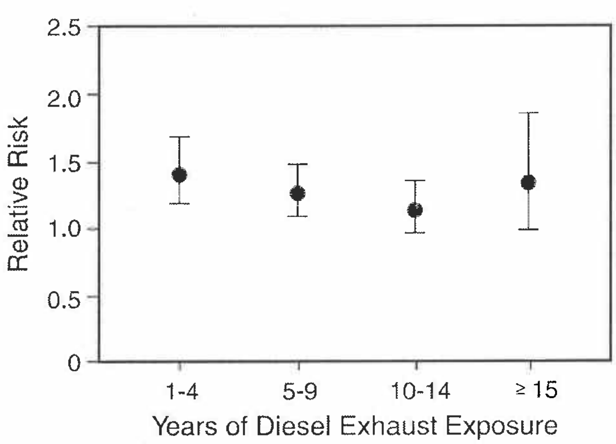

Figure 5. Relative risk of lung cancer by years of employment in the railroad industry through 1976. (Adapted from Table 4 in Garshick 1991.)

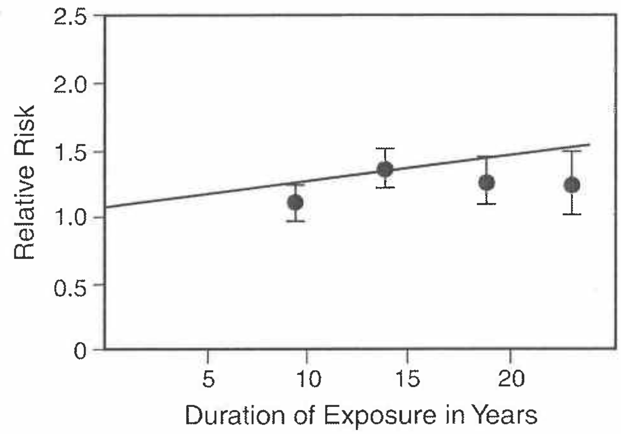

Figure 6. Relative risk of lung cancer by years of exposure to diesel exhaust. (Adapted from Figure 7-2 in OEHHA 1998.)

The analysis by OEHHA (1994, 1998) found a steadily increasing risk of lung cancer with increasing duration of exposure (Figure 6). This result conflicts with the findings of Crump and colleagues (Figure 4) and the revised Garshick analysis (Figure 5). Although the linear regression coefficient is positive, the relation shown in Figure 6 does not appear to be monotonic. On the basis of the linear increase, the California EPA estimated a range of lifetime unit risk (95% upper limit) of lung cancer from exposure to DPM to be from 1.3×10^{-4} (lifetime-µg/m^3)$^{-1}$ to 2.4×10^{-3} (lifetime-µg/m^3)$^{-1}$. The estimated risks are based on several assumptions, including (1) a linear increase in DPM exposure concentrations from zero in 1945 to a peak in 1959 (described below as the "roof" pattern of exposure) that was 1 to 10 times the concentration measured in 1980; (2) a linear decline to the 1980 value after the initial increase and peak in 1959; (3) exclusion of shop workers from some analyses because their degree of exposure was uncertain; (4) various statistical methods to control for age and calendar year; and (5) subtraction of "background" exposure levels measured for clerks and signal maintainers from the exposure levels measured for the train workers.

Different assumptions were made by OEHHA and Crump to reconstruct diesel exposures before 1959, because no actual data were available. Figure 7 shows a schematic representation of how pre-1959 exposure was represented in analytic models by Garshick and colleagues (1988), Crump and coworkers (1991), and OEHHA (1998). The cohort analysis (Garshick et al. 1988) assumed that exposure began in 1959, and that the 1959 exposure level remained constant until 1980 (which has been referred to as the "block" exposure pattern). Crump used the "ramp" exposure pattern, with a linear increase in exposure from the

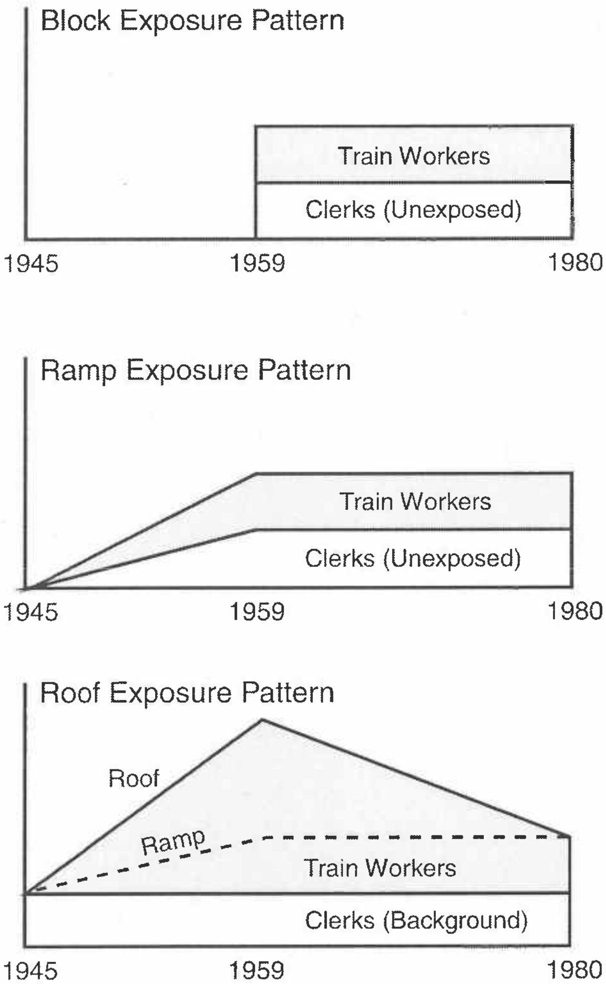

Figure 7. Different exposure patterns from assumptions made about pre-1959 diesel exposures. Garshick and colleagues (1988) made no assumptions about exposure before 1959, which has been referred to as a block pattern. Crump and coworkers (1991) assumed a linear increase in exposure from 1945 to 1959 and constant exposure thereafter (the ramp pattern). The roof pattern (OEHHA 1998) is based on the assumption that engines were "smokier" in the past, increased to a peak in 1959, and decreased to measured levels in 1980. (Adapted from Figure 7-4 in OEHHA 1998.)

time diesel-powered locomotives were introduced in 1945 to a peak of diesel engine use in 1959 and constant exposure levels from 1959 until 1980. This model assumes that exposures for both train workers and clerks followed this pattern, though at different magnitudes of exposure. The "roof" exposure pattern assumes a constant background level of exposure for the clerks before and after 1959. The additional exposure for the train workers was assumed to increase to a maximum in 1959 of three times the exposure level of the ramp model, followed by a decreasing exposure to the levels measured in 1980. Analysts at OEHHA used the roof model of diesel exposure because they thought it more nearly approximated anecdotal reports that engines were "smokier" in the past, and decreased to levels measured in 1980 (OEHHA 1998).

TEAMSTER STUDIES

CASE-CONTROL STUDY

Steenland and colleagues (1990) conducted a case-control study of lung cancer mortality in the Central States Teamsters Union. Cases and controls were selected from among 10,699 male union members who had filed for pension benefits and who died in calendar years 1982 and 1983. Cases ($n = 996$) constituted all deaths in which lung cancer was reported as an underlying or contributing cause of death (ICD code 162 or 163). Control subjects ($n = 1,085$) consisted of every sixth death in the file of decedents, excluding deaths from lung or bladder cancer and motor vehicle accidents. As with the railroad worker case-control study, deaths from nonmalignant respiratory disease were included among the control subjects.

Exposure to diesel exhaust was ascertained in two ways. Interviews with the next of kin were conducted for 82% of cases and 80% of control subjects to obtain a lifetime work history. Study subjects were classified according to the job category in which they had worked the longest: diesel truck driver, gasoline truck driver, driver of both types of trucks, truck mechanic, or dock worker (a person who worked on truck loading docks or in warehouses). Subjects who had never worked in any of the above categories were defined as unexposed to diesel exhaust.

The second source of exposure information consisted of Teamsters Union pension applications that had been completed by the study subjects; these listed each occupation, employer, and the dates of employment. As with the data provided by next of kin, study subjects were categorized according to the job they held the longest: long-haul driver, short-haul or city driver, truck mechanic, or dock worker; others were classified as unexposed. Most subjects had worked in only one job category. The Teamsters Union data did not provide information on whether trucks were gasoline or diesel. The concordance between exposure classifications based on Teamsters Union records and on the next-of-kin interviews was generally high, but it varied among job categories. Over 90% of the men identified by their next of kin as diesel truck drivers were listed as long-haul drivers in the Teamsters Union records, and 82% of workers identified as mechanics by their next of kin were listed as such in the same records. Information on the amount and duration of cigarette smoking was obtained from the next of kin, as was information on asbestos exposure and diet.

When subjects who had ever been employed in any of the index job categories were compared with those who had not, the relative risk of lung cancer was elevated (but not statistically significant) in all major occupational categories except dock workers. Relative risk estimates for lung cancer appeared to increase with duration of employment after 1959 for both long-haul and short-haul truck drivers.

A similar pattern was observed in analyses that were based on length of employment as a driver of diesel trucks, using job histories provided by the next of kin. Employment as a diesel truck driver for 35 years or longer was associated with an 89% increase in lung cancer mortality (RR = 1.89; 95% CI: 1.0, 3.4). However, no relation between duration of employment and excess lung cancer mortality was evident for mechanics working 35 years or more (RR = 1.09; 95% CI: 0.44, 2.7).

INDUSTRIAL HYGIENE STUDY OF TRUCKING INDUSTRY WORKERS

In conjunction with the case-control study of teamsters, Zaebst and colleagues (1991) surveyed exposures to DPM in the four job categories identified by the Teamster Union records: long-haul or road drivers, short-haul or local drivers, mechanics, and dock workers. This survey was conducted in a time period after workers in the epidemiologic study would have been exposed. Samples were measured among workers in these four groups at six "breakbulk" terminals (hubs where inbound long-distance loads are broken into smaller loads for delivery). Additional data were obtained for dock workers at another terminal and for mechanics at a small truck repair shop. In addition, area samples were collected near a highway and in a residential area to estimate background concentrations. Levels of submicrometer-sized elemental carbon (EC_1) particles were used as the principal marker of exposure to whole diesel exhaust. Table 2 presents the EC_1 data from the industrial hygiene study and the odds ratios from the epidemiologic study.

Steenland and colleagues (1992) interpreted the EC_1 measurements as being generally consistent with the epidemiologic results. The industrial hygiene survey (Zaebst et al. 1991) indicated that measured levels of EC_1 for drivers did not differ substantially from highway background levels at the time of the survey.

Different numbers of dock workers were reported by Zaebst and colleagues (1991) and Steenland and colleagues (1998). In 1991, the industrial hygiene study reported that dock workers used equipment with engines powered by diesel (n = 54), gasoline (n = 9), or propane (n = 12). However, primarily propane-powered engines were used by dock workers until diesel-powered engines were introduced in the early 1980s, which is an insufficient latent period for development of lung cancer in 1982 and 1983, when subjects were identified for the epidemiologic

Table 2. Sample Means of EC_1 and Estimates of an Association Between Exposure to EC_1 and Lung Cancer Risk by Job Category in the Trucking Industry[a]

Job Category or Location[b]	n	EC_1 Geometric Mean ± SD[b] (μg/m^3)	EC_1 Arithmetic Mean ± SE[b] (μg/m^3)	Odds Ratio (95% CI)[c]
Dock workers	12	1.3 ± 2.0	1.6 ± 0.4	0.93 (0.55, 1.55)[d]
Mechanics	80	12.1 ± 3.7	26.6 ± 4.1	1.69 (0.92, 3.09)
Short-haul drivers	56	4.0 ± 2.0	5.4 ± 0.9	1.31 (0.81, 2.11)
Long-haul drivers	72	3.8 ± 2.3	5.1 ± 0.4	1.27 (0.83, 1.93)
Roadside area samples	21	2.5 ± 2.4	3.4 ± 0.5	NA
Off-roadway area samples	23	1.1 ± 2.0	1.4 ± 0.2[e]	NA

[a] Table compiled from Steenland and associates (Table 2 in 1990, Table 1 in 1998) and Zaebst and coworkers (Table 3 in 1991).

[b] From Zaebst and coworkers (1991).

[c] From Steenland and associates (1990). Reference job category for odds ratios is workers who had never worked in the other job categories listed nor in any other diesel-exposed job. NA = Not applicable.

[d] Odds ratio from Steenland and associates (1998) for dock workers using propane forklifts only.

[e] Value taken from Zaebst and coworkers (1991); same value appears as geometric mean for off-roadway area samples in Steenland and associates (1998).

study. Subsequent reports utilizing these industrial hygiene data include exposure levels measured only among those 12 dock workers using propane-powered equipment (Steenland et al. 1992, 1998).

EXPOSURE-RESPONSE ANALYSES

Steenland and colleagues (1998) reported results of an exposure-response analysis for EC_1 exposure as a marker for diesel exhaust and lung cancer in the teamster study. In the original case-control study, Steenland and colleagues (1990) had estimated exposures for subjects from work history. Industrial hygiene measures (Zaebst et al. 1991) were combined with past estimates of worker exposure on the basis of the investigators' evaluation of changes over time in both diesel engine emissions and patterns of use in the transportation industry. The estimated exposures from work histories and the industrial hygiene measures were combined with the following assumptions to develop the exposure-response relation.

- Ambient diesel exposure for workers in the trucking industry increased in proportion to the use of diesel engines.
- Past exposures to diesel emissions were estimated using heavy-duty trucks as a marker of diesel engine use and data on vehicle miles traveled (VMT) by heavy-duty trucks from 1949 to 1990.
- Worker exposures were assumed proportional to diesel engine emissions, as estimated from past engine emission levels and changes in emissions over time using existing data on grams emitted per mile traveled.
- The mid-point value of emissions decreased from 4.5 grams per mile in the 1970s to 0.4 grams per mile in the 1990s for new heavy-duty trucks.
- For the subjects in the epidemiologic study, past exposure to EC_1, as a marker for diesel exposure, was estimated by assuming that (1) the average 1990 level could be assigned to all workers in a specific job category; and (2) levels before 1990 were proportional to VMT by heavy-duty trucks and the estimated emission levels of diesel engines.
- Long-haul drivers received some exposure from their own trucks, increasing their estimated exposure by 50% (based on Ziskind et al. 1978).
- Ambient air background levels (1 $\mu g/m^3$/year) were added to the cumulative worker exposure.

Cumulative exposure estimates were calculated for workers by each year of work history and job category. The largest job category was long-haul drivers, and estimates of lung cancer risk were calculated for this group. All analyses were controlled for age, race, smoking, diet, and reported asbestos exposure. Results indicated that a lifetime excess risk of lung cancer death from exposure to 5 $\mu g/m^3$ EC_1 (through age 75) for a male truck driver was 1.6% (95% CI: 0.4, 3.1); that is, an excess of 1.6 deaths from lung cancer for each 100 men. (The excess risk at 1 $\mu g/m^3$ EC_1 is 3×10^{-3}.) The assumptions in the estimate were that emissions in 1970 were 4.5 grams per mile, the worker had 45 years of exposure (from age 20 to 65) at 5 $\mu g/m^3$ EC_1, and there was no lag time when the cumulative exposure was calculated. (Investigators reported that similar findings resulted when a lag was included.) Varying the assumption of level of exposure in 1970 resulted in an estimated range of lifetime risk from 1.4% (95% CI: 0.3, 2.7) to 2.3% (95% CI: 0.5, 4.6). (This range is higher than the unit risk estimate calculated by OEHHA from the railroad worker cohort data.)

Assessment of Railroad Worker and Teamster Studies

When the Panel started to evaluate the epidemiologic studies of diesel-exposed workers, one challenge was understanding why the exposure-response association from various analyses of the railroad worker cohort data produced apparently conflicting results. Another was whether and how to address the exposure-response analysis of the teamster data (Steenland et al. 1998), which was published after the Panel's work was under way, and had not been subjected to the same level of scrutiny as the railroad worker studies. The Panel concluded that both sets of studies should be systematically reviewed to weigh their strengths and limitations for QRA.

In general, the results of both sets of studies are consistent with findings of a weak association between death from lung cancer and occupational exposure to diesel exhaust. Although the secondary exposure-response analyses of the railroad worker cohort data are conflicting, the overall risk of lung cancer was elevated among diesel-exposed workers.

In addition to the availability of some associated exposure data, several strengths are evident in these railroad worker and teamster studies. Both included large numbers of subjects (55,407 employees with 1,694 lung cancers comprised the railroad worker cohort, and 1,256 lung cancers were the basis for the case-control study; the teamster case-control study was based on 996 lung cancers) from industries in which some occupations entailed exposure to diesel exhaust. Job categories with known exposure to asbestos were either excluded or controlled for in the analyses. Both of the case-control studies adjusted for cigarette smoking as a confounding variable in analyses of the relation between diesel exposure and lung cancer mortality.

The Panel addressed the questions posed in its framework (see Table 1 in the Background chapter and Appendix B) for evaluating the railroad worker and teamster studies. Because the questions represent an ideal study, the Panel did not expect a strict "yes or no" response to each question. Instead, the systematic evaluation of these studies within this framework was intended to inform the process for others who may want to understand or use these data, and to provide a means to weigh study strengths and limitations. This systematic approach also was intended to sharpen the focus on where limitations from previous work might help define research needs.

RAILROAD WORKER STUDIES

DESIGN

1. **Was the study design efficient, and did it specifically consider power, potential types of bias, and latency?**

A cohort study (Garshick et al. 1988) and a case-control study (Garshick et al. 1987) reported findings on railroad workers. The authors did not report how power calculations were conducted or whether factors other than overall association between diesel exposure and lung cancer were considered. For weak associations, even large studies may not be powerful enough to detect associations, particularly in subanalyses.

A cohort study design, as used by Garshick and colleagues (1988), is appropriate for enumerating the workers to be followed for development of disease. A case-control study design requires additional assumptions for use in QRA; when the case-control study is not nested in a cohort design (as it was not in Garshick et al. 1987), still more assumptions are required, which can limit the conclusions to be drawn. For example, it is possible that the deaths in the case-control study did not include all lung cancer deaths that occurred in the population eligible for RRB death benefits, because both cases and controls were deaths identified between March 1, 1981, and February 28, 1982, which was after the period when follow-up was considered complete in the cohort study as reported by Crump and colleagues (1991).

A case-control study may be less suitable than a cohort study for QRA; if the control causes of death used are related to smoking or to other risk factors for lung cancer, including the exposure of interest, this may lead to biased results. Control deaths (Garshick et al. 1987) were primarily from cardiovascular disease (CVD), which is also associated with cigarette smoking. If risk of CVD differed among job categories (that is, by exposure), and within category of smoking status, a selection bias may have been introduced. The authors did not discuss such a possibility in their published report. A case-control study nested in the cohort study would be a preferable study design because it avoids such bias.

In the cohort study, subjects were followed for up to 21 years. This may have limited the power of the study by providing too short a latency period for the manifestation of lung cancer, given that the latency period from exposure to a substance until the development of solid tumors is often 20 to 40 years (although some can appear in 10 years or less).

2. Were adequate quantitative exposure and covariate data planned and collected?

Both railroad worker studies were retrospective studies conducted on the basis of death certificates, which obviously precluded interviewing subjects to obtain exposure data. However, an industrial hygiene survey of the railroad industry was conducted to measure RSP adjusted to remove the ETS fraction, as a marker for DPM (Woskie et al. 1988a). This survey was conducted at a nonrandom sample of four small railroads, and measurements were in a time period after the cohort members were exposed. The diesel-exposed or unexposed job categories in the epidemiologic studies, which had been designated on the basis of job title and duties, were confirmed with the industrial hygiene samples of railroad jobs (Woskie et al. 1988a,b). (For a more detailed discussion of exposure issues, see the Exposure Assessment section.)

3. Was the literature reviewed for relevant study methods and previous research findings?

The literature review in the main report of the cohort study did not include references related to QRA. Such references would not be expected, however, because a QRA was not originally intended.

4. Were plans made for postpublication data scrutiny?

The Panel did not know whether the researchers originally intended to share their data. The investigators did, however, generously share data with the U.S. EPA (and, through the EPA, with Dr. Crump). In turn, Dr. Crump shared the data with Dr. Dawson in the OEHHA (California EPA). Most recently, all of these individuals have shared data with the HEI Panel. This was extremely valuable in understanding the complexities inherent in this data set, and the Panel greatly appreciated all of their cooperation.

EXPOSURE ASSESSMENT

1. Were detailed lifetime histories of occupational exposures collected?

All members of the cohort were active railroad workers in 1959 and had at least 10 years' history of employment; investigators reported that no information on work histories was available for the years before 1959 (Garshick et al. 1988). This lack of data on exposures before 1959 adds to the uncertainty in quantitative risk estimates developed from studying this cohort. The researchers chose 1959 as the starting date because approximately 95% of railroad locomotives were diesel-powered (as opposed to steam-powered) by that time, according to a U.S. Department of Labor report (1972). Duration of employment since 1959 was used to represent the duration of exposure to diesel exhaust after 1959. Although the investigators had neither a detailed occupational history nor a history of exposure, they verified that more than 90% of workers who were between 40 and 44 years of age in 1959 remained, over their careers, in job categories with the same exposure classification. Garshick and colleagues (1988) accounted for exposure history in "diesel-years," that is, the total number of years in a diesel-exposed job category from 1959 until death or retirement.

2. Were known chemical and physical characteristics of the main exposure specified?

In the original cohort study, the main exposure of the railroad workers was considered to be "diesel exhaust," which is a complex mix of many compounds in both particle and gas phases. Little historical information was available on the chemical and physical nature of the diesel emissions from locomotives, or on how the emissions might have varied by railroad or job category over the time period covered in the cohort study. The industrial hygiene study, conducted between 1981 and 1983, focused on RSP as a marker for exposure to diesel exhaust, but diesel exhaust is only one of many sources of ambient particulate matter. The contribution of ETS, a major source of indoor particles, to the total particulate samples was adjusted for by a correction factor derived from measured particle-phase nicotine (Hammond et al. 1988). Levels of NO_2, a constituent of diesel exhaust, were examined at the four studied railroads across seasons, but this measurement was not useful for distinguishing among the job categories (Woskie et al. 1989).

3. Were potentially confounding exposures measured or estimated?

In the railroad worker studies, sources of exposure to respirable particulate matter in addition to diesel exhaust were likely to include outdoor nondiesel pollution, personal activities (e.g., smoking), indoor residential exposures (e.g., ETS or residential coal heating), and other occupational exposures (e.g., asbestos). These exposures, if related to both diesel exposure and lung cancer, could be considered possible confounders. That all of these exposures were confounding variables is unlikely.

Asbestos, however, is a potentially confounding exposure among railroad workers. The railroad worker cohort study excluded workers in job categories known to be "asbestos-exposed," and analyses were conducted both with and without the inclusion of job categories in which asbestos exposure was suspected. The case-control study controlled for asbestos exposure in the statistical analysis (Garshick et al. 1987). The possibility of confounding by other exposures before 1959 could not be completely evaluated.

Retrospective mortality studies have limited ability to obtain good data on risk factors such as smoking or lifestyle variables, which often must be obtained from next of kin. The case-control study included smoking data from next of kin; the investigators reported that when results were adjusted for smoking, they did not differ substantially from unadjusted results. Thus, it is likely that results were not seriously confounded by smoking. However, because smoking is strongly associated with lung cancer in most studies, and because the reported association between diesel emissions and lung cancer is weak, smoking needs to be controlled precisely in analyses of the effects of exposure to diesel exhaust. Even if smoking is not shown to be a confounder in a particular study, when a weak association between a risk factor and lung cancer is under investigation, the validity of any findings is likely to be questioned if the analysis did not control for smoking. In addition, smoking may modify the risk of exposure to diesel exhaust, and this modification can be investigated only if smoking data are available.

In the industrial hygiene study by Hammond and colleagues (1988), the ARP removed the ETS contribution. The adjusted marker (ARP) is an improvement over a crude classification of each job as either exposed or unexposed to diesel exhaust with no consideration of either smoking or ETS. When the ETS estimate was subtracted from the RSP concentration, ranking of the diesel-exposed job categories changed from that based on RSP alone.

Woskie and colleagues (1988b) developed a model for estimating mean levels of DPM exposure in national career groups. Although this model included data on ARP concentrations, railroad job category, and climate, it did not consider the impact of outdoor nondiesel particulate matter on estimates of exposure to DPM; instead, one estimate of the contribution of outdoor particulate levels was applied to all workers regardless of location or time. This procedure is questionable, however, because outdoor particulate mass concentrations show considerable geographic variability across the U.S., and over time; substantial reductions have been noted in measured levels. For example, the trend in particle emissions data indicates a threefold reduction in emissions between 1940 and 1982 (National Air Pollutant Emissions Trends 1997), a time that overlaps the period during which the railroad worker cohort was exposed. Considering background outdoor particulate levels over space and time, and by railroad, might substantially alter estimates of total particle exposures, and hence alter estimates of the health effects of diesel exhaust.

4. Were magnitude, duration, and variability of exposure determined?

Exposure data were collected by Woskie and colleagues (1988a,b) several years after the workers in the epidemiologic studies were exposed. The 13 job codes from the industrial hygiene studies were combined to develop the 5 career groups as shown in Table 3. (Arithmetic means are presented rather than geometric means, because comparable data were available in this form for each of the exposure estimates.) The authors discussed some concerns they had about the exposure data used in the model to estimate the national career group mean exposures (Table 3, last column). Particle mass measurements varied considerably among the job groups for both corrected (ARP) and uncorrected (RSP) concentrations. The uncertainty associated with the final grouping of occupations into these job categories should be considered when the exposures for each group are discussed.

Table 3 indicates that several job exposure groupings are possible, with all such groupings having an undefined but large uncertainty. For example, clerks (who are considered "unexposed") appear to have RSP exposures (RSP = 125) similar to those (RSP = 126) of freight conductors (who are considered "exposed"). Engineers and firers, and brakers and conductors are combined as "exposed"; however, their RSP estimates range from 75 (passenger engineers and firers) to 231 (hostlers). When ARP values are considered, clerks (ARP = 42) and signal maintainers (ARP = 58) appear to have more similarly low exposures than when RSP is used. However, passenger engineers and firers (ARP = 51), yard engineers and firers (ARP = 69),

Table 3. Railroad Worker Exposure Assessment Data[a]

Career Group	Job Group	Number of Workers Monitored[b]	Number of Samples Used for ETS Estimates[c]	Particle Concentration as Arithmetic Mean: RSP[d] (± SD)	ETS[e]	ARP[f] (± SD)	AEM[g]	Modeled National Career Group[h] Mean ± SD (μg/m³)
Clerks	Clerks	59	36	125 ± 75	88	42 ± 36	7	33 ± 1
Signal maintainers	Signal maintainers	13	14[i]	69 ± 39	10	58 ± 33	23	58 ± 4
Engineers and firers	Freight	55	37	115 ± 67	18	94 ± 55	30	71 ± 3
	Yard	50	20	108 ± 109	44	69 ± 70	24	
	Passenger	23	21	75 ± 52	23	51 ± 35	16	
Brakers and conductors	Freight conductors	62	48	126 ± 65	52	69 ± 52	30	89 ± 3
	Freight brakers	21	16	145 ± 80	36	102 ± 62	8	
	Passenger	35	33	111 ± 62	6	104 ± 58	27	
	Yard	32	7	180 ± 117	75	114 ± 76	17	
	Hostlers	8	8	231 ± 134	7	224 ± 130	33	
Shop workers	Electricians	42	16 (Summer)	256 ± 332	37	192 ± 248	37	141 ± 8
	Machinists	110	32 (Summer)	191 ± 146	29	147 ± 120	55	
	Supervisors and other shop workers	24	12	244 ± 141	30	155 ± 83	43	

[a] Adapted from Hammond and colleagues (Table 2 in 1988) and from Woskie and coworkers (Tables 2, 4, and 5 in 1988a; Table 1 in 1988b).

[b] Number of workers monitored over one work shift with a personal monitor for particle mass (Woskie et al. 1988a).

[c] From Hammond and associates (1988).

[d] RSP = concentration (μg/m³) of respirable particle mass (≤ 3.5 μm) measured by personal monitors for four railroads (Woskie et al. 1988a).

[e] ETS = respirable particle mass concentration (μg/m³) associated with ETS (Hammond et al. 1988), determined from the analysis of composite personal monitoring particle mass samples by job group and railroad for three railroads.

[f] ARP (in μg/m³) = (RSP − ETS)/volume of air sampled (Woskie et al. 1988a).

[g] AEM (in μg/m³) = [(μg RSP × fraction extractable) − (μg ETS × fraction ETS extractable)]/volume of air sampled (Hammond et al. 1988).

[h] Modeled national career group exposure determined from model that incorporates ARP concentrations, national railroad worker job data, and climate data in a linear model (Woskie et al. 1988b).

[i] Numbers as reported.

and freight conductors (ARP = 69) also appear to have low-level exposures, although for analysis they are considered "exposed" along with those who are listed with much higher ARP levels. Such misclassification as to which jobs are considered "exposed" or "unexposed" could bias study results.

The variability in job exposure estimates may be the result of several assumptions that were made in the industrial hygiene study. First, the selection of a 10°C cut point to represent climate effects on DPM exposures is arbitrary and not well supported. Second, repeated personal monitoring on a subpopulation of workers in different job groups would have been preferable to a single measurement for estimating measurement error and day-to-day variability. Variability associated with these sources may add considerable uncertainty to estimated job group exposures. Concentrations of RSP in various job groups might have changed substantially over time in ways that could be related to newer engine technology, changes in ventilation, differences in diesel maintenance practices, or other variables not examined. The model of career exposure means (last column of Table 3) would have been more informative for use in QRA if the model had considered various scenarios of time-varying concentrations.

5. Were industrial hygiene data and historical data on use and repair of machinery and equipment obtained?

Although Woskie and colleagues (1988b) obtained some information on national dieselization of the railroad industry, actual exposure measurements were made at four small railroads that were unlikely to represent the national diversity of equipment and exposures. Detailed historical exposure conditions in the railroad shops were evaluated in terms of NO_2 levels, historical records of use and changes in ventilation systems, and a comparison of records of historical locomotive use with locomotives in use at the time of the industrial hygiene study. Detailed historical information on the purchase and maintenance of diesel locomotives, fuel use, and repair shop design, helpful to the historical reconstruction of exposures, was not available. Such additional information might better define historical exposure trends by railroad.

6. Were personal exposure measurements obtained, and were they representative of the population studied?

The industrial hygiene exposure assessment provided information that identified categories of railroad workers who might be at risk of exposure to diesel particulate emissions from locomotives. As noted, however, the results in Table 3 indicate that other groupings of diesel-exposed jobs are possible, which introduces additional uncertainty in the exposure data for use in QRA.

The exposure assessment conducted by Woskie and colleagues (1988a,b) probably does not represent personal exposures of railroad workers to diesel exhaust in either space or time, and raises several issues. First, the four small railroads sampled by Woskie and colleagues are in the northern U.S. and are not necessarily representative of the national average railroad exposure, during either the period of sampling (1981–1983) or the period of exposure covered by the epidemiologic studies (1959–1980). Second, a convenience sample of 530 workers from 39 job codes was selected for personal monitoring of particle mass during a single work shift, which may not accurately represent exposures of all workers in those job codes. Third, corrections to particle mass exposures were determined from composites of personal samples within job group at each railroad (Hammond et al. 1988). Data on ETS were available from only three of the four railroads. Although the composite samples were necessary to have a sufficient mass of particulate matter for marker analysis, the few resulting observations did not allow assessment of the variability of the contribution of ETS and inorganic mass (e.g., sand, dirt, fibers) to the measured personal diesel exposures either by job group or by railroad. A statistically drawn random (e.g., stratified random) sample from railroads across the country would have provided greater confidence in the representativeness of the data.

7. Were uncertainties in exposure assessment quantified?

When Woskie and colleagues (1988a) developed their exposure intensity estimates for various job categories, it was not with the intention that the estimates would be used for QRA. Woskie and colleagues provided estimates of error resulting from sampling variation but did not quantify uncertainties from all sources, as would be desirable for results intended for use in QRA. Sources of uncertainty include (1) extrapolation of data from four railroads to the entire U.S., (2) use of results from 1980 to estimate earlier exposures, (3) lack of exposure histories prior to 1959, (4) failure to account for seasonal variations in exposures, (5) problems in selecting the appropriate job category groupings, and (6) use of respirable particulate matter as a surrogate measure of DPM. Analysts who have made use of the Woskie and colleagues data (Crump et al. 1991; OEHHA 1998) also have not quantified uncertainties from all sources, although these analysts discussed problems with the exposure measurements.

OUTCOMES

1. Were outcomes defined in specific and objective terms?

Death certified as primary lung cancer was defined as the outcome for the railroad worker case-control study (Garshick et al. 1987). In the cohort study (Garshick et al. 1988), the outcome included lung cancers mentioned either as the underlying cause of death or elsewhere on the death certificates. Lung cancers identified on death certificates can include false positive identification of disease, especially if a cancer is metastatic rather than primary in the lung, in addition to false negatives from certification of deaths to some other disease when lung cancer is the cause. That is, death certificates are likely to overestimate the number of lung cancer deaths by including metastatic sites. The best identification of lung cancer for incident cases would be by pathologic examination of a tissue specimen; however, this process is more expensive than a death certificate review. If some cancers metastatic to the lung were differentially misclassified as primary cancers, the impact on risk estimates used in QRA could be in either direction.

2. Was the full range of outcomes included in cohort studies?

Garshick and colleagues (1988) reported only lung cancer in their cohort study, whereas Crump (1999) has looked at other mortality outcomes in association with exposure to diesel exhaust, including heart disease and stroke. These findings have shown decreased risk for overall mortality, as well as for cause-specific mortality, with longer duration of employment.

3. Were participants actively followed to determine outcome status and the date outcome occurred?

Crump and colleagues (1991) compared all-cause mortality in the railroad cohort with U.S. mortality rates, and showed that follow-up was incomplete after 1976. They found that although age-specific death rates in the cohort (overall job categories) remained fairly constant through 1976 (consistent with the U.S. pattern in this period), after 1976 death rates for the cohort dropped (Crump et al. 1991). Garshick reexamined the data and verified that mortality follow-up after 1976, as determined by the RRB, was incomplete (1991). In the cohort study, mortality was determined using the records of the RRB benefits plan. This appears to have been an incomplete method of mortality follow-up, and whether the incomplete follow-up is nondifferential by job category is unknown.

ANALYSIS

1. Were analytic methods specified a priori?

The original investigators were clear that they would use job category and employment duration to estimate exposures to diesel exhaust among job categories without attempting to make quantitative estimates. Although the Panel did not have the original protocol for this study, no evidence would indicate that the approach used was influenced by the hypothesized relation between potential exposure measures and risk of death from lung cancer. Crump and colleagues (1991) used quantitative data to distinguish among job categories and considered many different measures of exposure, all of which led to a similar conclusion; that is, the risk of lung cancer decreased with longer duration of employment. The OEHHA (1998) based most of its analyses of the cohort data on a metric of duration of employment and on the difference between train workers and clerks; however, it considered a variety of assumptions regarding increasing diesel exposure until 1959 and its gradual decrease afterward.

2. Was the appropriateness of the statistical approach demonstrated, and were potential biases explored?

The published models for the cohort and case-control studies did not report any validation procedures. Of possible concern in these models is that age in 1959 was treated as a continuous variable*, and no term was included for interaction with calendar year, which would have adjusted for attained age† and calendar year. Other analysts of the railroad worker data have used different approaches for adjusting for age and calendar year.

The OEHHA did not account for variations in risk by job category, and none of the analysts fully investigated the possibility that time patterns of lung cancer development might differ for various subgroups. The investigators did not publish a description of how *p* values and confidence intervals were calculated.

3. Were exposure-response relations statistically explored?

The conflicting results obtained by secondary analyses of the railroad worker data are central to the issue of whether these data should be used in a QRA of diesel exhaust. Although the railroad worker data have been used for QRA, Garshick (1998) has not supported this use.

The model used for the original railroad data analysis (Garshick et al. 1988) was limited, and neither goodness of fit nor attempts to quantify the risk as a function of exposure were explored. The analysis included a comparison of estimates by age in 1959, and interpreted the larger risks for the younger age groups as reflecting larger cumulative exposures for the younger subjects rather than as effect modification.

Results in the railroad worker study have been analyzed with either no lag time to allow for latency or induction of cancer, or with a five-year lag. The five-year lag was used by secondary analysts (Crump et al. 1991; OEHHA 1998; Crump 1999).

In the original analysis of the cohort railroad data (Garshick et al. 1988), exploration of alternative models was limited to an analysis considering a lag period and an analysis that excluded shop workers and hostlers who

* When age is treated as a continuous variable, the actual age of the subject is included in the analysis. If age is considered as a categorical variable, ages of the subjects are divided into either 5- or 10-year groups, for example, and a variable representing the age group is included in the analysis rather than the actual age.

† Attained age is the age at risk for a particular calendar period and would include everyone in the cohort who is at risk.

may have been exposed to asbestos. The OEHHA explored ramp and roof patterns of pre-1959 exposures, as well as several approaches for adjusting for age and calendar year period. Crump's original work (Crump et al. 1991) explored different models for adjusting for the effects of age, calendar year, and exposure groups.

In the analysis of the railroad worker cohort study (Garshick et al. 1988), with all job categories combined, relative risks appeared to increase with years of exposure to diesel exhaust (see Figure 3 in the chapter Summary of Railroad Worker and Teamster Studies); exposure in the year of death and the preceding four years was disregarded. This finding was important because it supported an exposure-response effect and stimulated interest in using these data for QRA.

The Panel has conducted its own limited analysis of the railroad worker data. The objectives of these analyses were specifically to assist the Panel in its task of verifying and better understanding previous analyses, and to clarify reasons for differences between the results obtained by Crump (see Figure 4; a negative exposure-response relation) and by OEHHA (see Figure 6; a positive exposure-response relation). The Panel's analyses were limited to these objectives only, and were not intended to be a complete exploration and evaluation of the railroad worker data or to provide a model for QRA. A detailed explanation of the Panel's methods of analysis, assumptions, and results is presented in Appendix C. The Panel also recognizes that its own analyses are subject to the same outside scrutiny as others' have received.

The Panel's data exploration indicates that overall, lung cancer risks for train workers, within each duration of employment group, were higher than those for clerks and signalmen; shop workers had intermediate risks (Figure 8). However, within the exposed groups (train workers and shop workers), lung cancer risk decreased with increasing duration of employment. Simple measures of exposure, determined by multiplying duration of employment by exposure intensities assumed to be constant for the clerks/signalmen and train worker groups, were also analyzed. With no adjustment for job category, a positive slope was obtained, which was statistically significant when zero intensity was assumed for the clerks and signalmen group. To clarify the extent to which this positive response was due to the difference in baseline risks for train workers compared with clerks and signalmen, the variable *GRP* to measure this difference was included in the model. When this was done, the direction of association with exposure became negative; this result reflects entirely the decreasing association with increasing employment duration for train workers, and demonstrates that the positive

Figure 8. Panel's analysis depicting consistently elevated risk of lung cancer for train workers compared with clerks for each time period, but decreasing risk by job category over duration of employment. See Appendix C for details.

exposure-response relation obtained, without adjusting for *GRP*, was entirely due to the baseline differences between the two job categories.

These patterns are not consistent with a monotonically increasing association between cumulative exposure to diesel exhaust and lung cancer risk. If risk increased consistently with increasing exposure, a positive trend with duration of employment would be expected for the exposed groups (including train workers), even if exposure magnitudes were incorrect (see Appendix C).

The Panel's analytic model that was similar to the model that served as the basis for the California OEHHA risk assessment did not fit the data; a strong improvement was seen in the fit of the model with the addition of a variable reflecting the difference between train workers and clerks/signalmen. Although some definitions of exposure used by the Panel and by the OEHHA were different, it seems unlikely that these differences affected the Panel's qualitative conclusions.

The Panel's conclusions regarding the railroad worker data analyses did not depend either on method of adjusting for age and calendar time or on the assumption about exposure patterns before 1959.

Crump and colleagues (1991) and Crump (1999) have reported various analyses of the railroad worker data, and have investigated duration of exposure since 1959 as well as more complex measures of exposure than those cited here. However, all results are likely to reflect the negative association of risk with increased duration of employment within job category groups. Crump (1999) has noted that the OEHHA positive slope is driven by the difference in risk between train workers and clerks, and the Panel's analyses confirm this. By showing results of analyses with and without adjustment for job category (intended to indicate exposure intensity), the Panel has attempted to clarify the roles of job category and duration of employment in the differences in results obtained by the OEHHA (1998) and by Crump and colleagues (1991, 1999). An expanded discussion of the Panel's analyses is in Appendix C.

4. Were uncertainties in risk estimates quantified, especially those resulting from exposure measurement error?

All analysts of the railroad worker data have evaluated statistical uncertainties, although the assumptions underlying the normal approximations were not validated. Uncertainties in the risk estimates resulting from exposure measurement error were not explored by any of the analysts. However, this was not relevant for the cohort study (Garshick et al. 1988), because that study did not use quantitative measures of exposure. Crump and colleagues (1991) did not specifically address the issue of measurement error, but presented results on the basis of several definitions of cumulative exposure and examined the effect of excluding shop workers from the analyses. They also commented on the uncertainties in exposure estimates and the possibility that these uncertainties could mask or distort diesel-related effects. The OEHHA (1998) listed uncertainties in the mathematical aspects of modeling, and used several simple models to explore some of the variability due to uncertainty (see Appendix F of its report).

DISCUSSION OF USING RAILROAD WORKER DATA FOR QUANTITATIVE RISK ASSESSMENT

The original railroad worker studies (Garshick et al. 1987, 1988) reported an elevated overall risk of lung cancer with increasing years of exposure to diesel exhaust, when all job categories were combined; however, when the Panel analyzed the cohort data by duration of employment for each job category, a negative association was seen in each group. That is, among train workers, and to a lesser extent among shop workers, the relative risk of lung cancer does not appear to increase with longer duration of employment (Appendix C).

A negative exposure-response relation might be present in these data for several possible reasons: several types of bias could affect the data, alone or in combination, in such a way as to mask a true positive association. For example, results could be affected by unmeasured confounding variables, such as cigarette smoking, previous occupational exposures, or other sources of pollution, that might be associated with diesel exposure as well as lung cancer. As noted previously, smoking, which is strongly associated with lung cancer risk, could not be assessed directly in the cohort study (Garshick et al. 1988), and estimates of lung cancer risk from the case-control study might have been biased.

Exposure misclassification is another possible source of bias in these data, especially because a dichotomous assignment of diesel exposure ("yes" or "no" by job categories) is a crude method for determining exposure. Also, the year when workers were first exposed to diesel is unknown. If dieselization was 50% complete in the early 1950s, some workers in a job category could actually have more "exposure duration" than others in the same category, thus diluting a possible association among those exposed the longest. Dosemeci and Stewart (1996) have demonstrated the impact of misclassification in exposure categories on estimates of relative risks. If misclassification is random (that is, there is no overall tendency for over- or underestimation of exposure), estimated risks are likely to be lower than their "true" values. Their findings show that the magnitude of bias depends strongly on the proportion of misclassified subjects. Job categories of exposure overlap (Table 3) and such a multidirectional misclassification of exposure of an unknown proportion of workers seems likely.

Still another possible reason for the negative association might be the use of "duration of employment" as a measure of exposure. Calendar time and duration of employment are highly correlated, and separating out the effect of duration of employment could be difficult. Doll (1985) has reported examples of nonmonotonic increases in cancer risk with longer durations of employment in an occupationally exposed job, and indicates that using this variable alone could lead to findings requiring cautious interpretation.

One more possible source of bias in these data is the "healthy worker survivor effect" (Arrighi and Hertz-Picciotto 1994). That is, workers who are "healthier" and less susceptible to disease might stay in the work place longer, so that those employed for longer periods might show a smaller elevation in risk than those employed for a shorter duration.

Bias also could be introduced if lung cancer deaths were differentially or incompletely ascertained. If lung cancer were more likely to be underascertained among those employed longest in diesel-exposed jobs, the result would be a lower risk with longer duration of employment. However, such differential ascertainment seems unlikely.

The preceding critique emphasizes the challenges involved in correctly analyzing and interpreting these railroad worker data. The Panel's opinion is that discussion of the uncertainties in these data should accompany any presentation of a quantitative risk estimate. However, despite the reason or reasons why the relative risks in these data decrease with duration of employment, the lack of a positive exposure-response association in the railroad worker cohort data substantially weakens that study's potential to provide a reliable quantitative estimate of risk of exposure to diesel engine emissions.

TEAMSTER STUDIES

As indicated, the teamster exposure-response analysis (Steenland et al. 1998) was published only after the Panel started working; therefore, the evaluation of this set of studies is less extensive than for the railroad worker studies. Also, the Panel did not request data from these investigators, thus its assessment was made on the basis of the published reports only.

DESIGN

1. Was the study design efficient, and did it specifically consider power, potential types of bias, and latency?

The teamster case-control study identified cases and controls from among members of the Teamsters Union who filed for pension benefits after at least 20 years in the Union, and who died in 1982 and 1983. The cases were deaths from lung cancer, and the published study (Steenland et al. 1990) did not indicate the distribution of causes of death for the controls. It is likely that, as in the railroad study, control causes of death were largely related to CVD. If this is the case, some control causes of death may have been related to diesel exposure, smoking, or both. Bias resulting from control subjects used would affect the estimate of risk and any QRA based on the study results.

In the teamster study, mechanic was the job category with the highest assigned diesel exposure; intermediate were long-haul and short-haul truck drivers; dock workers were assigned low exposure; and the unexposed category was composed primarily of dairy workers. It is not known whether the risk of dying from any of the control causes of death differed among the job categories or within strata of cigarette smoking, because of differences in diet, physical activity on the job, or other factors. If the risk differed, study findings could be biased.

Workers had to have 20 years of tenure in the industry to be eligible to apply for pension benefits, and data analyses included models with either 1960 or 1965 as the start of a worker's exposure to diesel exhaust. Deaths were ascertained between 1982 and 1983. If the development of lung cancers has a latency period of 20 years, it is likely that only the minimum time period passed for the development of the tumors, because the latent period can be as long as 40 years.

2. Were adequate quantitative exposure and covariate data planned and collected?

Next of kin provided data on smoking, diet, work history, and asbestos exposure for cases and controls. The investigators used these data to evaluate and control for possible confounding effects of these exposures on the association between diesel exhaust exposure and lung cancer. Work history data also were included in the pension applications available in the Teamsters Union records.

An industrial hygiene survey (Zaebst et al. 1991) measured EC_1 as a marker for diesel exhaust. The samples were taken in a time period after cases and controls would have been exposed, and might not represent actual exposures in space and time. However, the estimated exposures of teamsters to diesel exhaust are of greater relevance to public health than those of the railroad workers, because the teamster exposures are closer to the range of ambient levels of diesel emissions.

3. Was the literature reviewed for relevant study methods and previous research findings?

The literature reviews in the teamster studies are partial and brief. Because the original case-control study was not designated for QRA, a review of relevant methods would not be expected.

4. Were plans made for postpublication data scrutiny?

Planning for postpublication data scrutiny generally is not a major consideration of researchers. However, understanding of the railroad worker data has improved with each additional review. If the teamster data also are reassessed by the original investigators and other analysts, this is likely to yield additional insights and understanding. The exposure-response findings are still "young" in the literature and can benefit from critical peer review, examination by other researchers, and further exploration of possible biases.

EXPOSURE ASSESSMENT

1. Were detailed lifetime histories of occupational exposures collected?

Work histories were obtained for cases and controls from two sources, next-of-kin interviews and teamster pension applications. Next-of-kin interviews, administered by phone (20%) and mail (80%) to spouses (76%)

and others (24%), included information on work histories and several potential confounders, including smoking, diet, and asbestos exposure. Workers were classified into the job (exposure) category in which they had worked the longest. The categories were truck driver (diesel, gasoline, or both), diesel truck mechanic, and dock worker. The uncertainties associated with using questionnaire data and the impact of those uncertainties were not assessed. Although most pension applications reported that the worker had worked primarily in one job category, the impact of changes among job categories was not explored.

Work histories in the teamster pension applications, including all teamster jobs, were self-reported. These were also reviewed and used to assign workers into job (exposure) categories, although records did not differentiate between diesel and gasoline truck engines. Again, workers were assigned to the category in which they were employed the longest. The Teamsters Union assigned a U.S. census code for occupation and industry for each job a man included in his pension application. The four main occupations, based on records, were long-haul drivers, short-haul or city drivers, truck mechanics, and dock workers. The uncertainties associated with the exposure categories derived from the teamster records, and from combining the information from both the teamster records and the interviews, were not explored.

2. Were known chemical and physical characteristics of the main exposure specified?

The case-control study did not include estimates of exposure, but a companion industrial hygiene study was conducted after the epidemiologic study period ended. Steenland and colleagues (1992) derived job-specific exposure estimates from industrial hygiene measurements of EC_1 made by Zaebst and colleagues (1991). EC_1 is a reasonable marker for DPM, at least in terms of establishing relative exposures. It is more specific to diesel exhaust than RSP and relatively free of interference from ETS, an important particle source. On the basis of EC_1 measurements, Zaebst and colleagues (1991) provided some useful insights into the nature of diesel exposure for teamsters.

Relating EC_1 to DPM can be complicated, because the EC_1 fraction of DPM is variable and has probably increased over the period of exposure (Sawyer and Johnson 1995). This matter needs to be explored further if a quantitative risk is assigned. A carcinogenic fraction in DPM has not been identified, and there is no assurance that the proportion between that fraction and DPM or EC_1 has been constant. However, EC_1 is probably the best marker for DPM available at this time.

Nondiesel sources of elemental carbon and their ambient concentrations have changed over time, and geographic differences in concentration probably exist as well. Other sources of elemental carbon include gasoline engines, tire and brake wear, stationary combustion sources, and industrial processes; nondiesel sources were not considered in the assessment by Steenland and colleagues (1998). Although elemental carbon from stationary sources may have decreased over time, a recent study reports a substantial elemental carbon contribution from gasoline engine emissions that should be further considered (Northern Front Range Air Quality Study [NFRAQS] 1998) in the retrospective assignment of exposures by use of a marker for a complex mixture.

3. Were potentially confounding exposures measured or estimated?

In the original teamster study, next of kin of the cases and controls were interviewed about the subject's smoking, dietary, and asbestos exposures. Work histories included employment in any previous diesel-exposed job. The analysis used information from next of kin to control for smoking and asbestos exposure. Spatial and temporal variations in individual exposures to outdoor nondiesel respirable particles and residential indoor air were not assessed. However, these exposures would be of concern only if they related to both diesel exposure and lung cancer.

4. Were magnitude, duration, and variability of exposure determined?

Several aspects of exposure estimation could have considerable impact on the exposure-response analysis. First, in the teamster case-control study (Steenland et al. 1990), exposure was determined by assignment to one of five job (exposure) categories. Each worker was assigned to the category in which he was employed the longest. This method of assigning exposure necessarily restricts a subject to one job, and does not allow for the use of the complete work history or the potentially wide variability of exposure among workers within a job category over time and in different locations. Thus, information on the magnitude, duration, and frequency of exposure to diesel exhaust by the workers was not directly collected or assessed.

Second, recent in-use measurements suggest that newer engines on the road have higher emissions than the engine measurements used by Steenland and colleagues (1998). Extrapolations from recently reported measurements of particulate emissions from in-use heavy-duty vehicle diesel engines suggest that emissions were about 5 grams per mile through 1980 and then began to fall as new technology was introduced, with the fleet average falling to about 2 grams per mile in 1990 (Graboski et al. 1998). This differs from Figure 3 in Steenland and colleagues (1998), which shows lower emission estimates for each of three different scenarios of changing emissions over time.

Third, dieselization was assumed to begin in 1949. However, the proportion of the fleet that was diesel-powered increased gradually until the 1970s, by which time most heavy-duty trucks sold were diesel-powered. Exposures to diesel engine emissions in the early years would not have been as great as later in the study period.

Fourth, the emissions data for heavy-duty trucks were linked to the industrial hygiene data for the various job categories, and this exposure was scaled to heavy-duty truck VMT. These assumptions need to be explored further. Linking emissions from heavy-duty trucks to off-road job categories, such as dock workers and mechanics, is probably not the most appropriate method to estimate those workers' exposures. Working environments on loading docks and in repair shops, particularly ventilation and temperature, can affect exposure estimates and are not accounted for in this approach to estimating exposure. Also, increasing VMT does not necessarily mean increasing exposures for these workers; more likely it means hiring more workers handle the additional work. How the heavy-duty truck emissions and VMT assumptions interact and affect exposure estimates applied to other job categories requires further investigation.

Fifth, the estimation of relatively high roadside and background exposures may overestimate ambient exposures.

In summary, the estimated historical exposures to diesel emissions are associated with several major uncertainties (Steenland et al. 1998), t e effects of which are difficult to estimate. The impact of varying the uncertainties associated with the assumptions needs to be addressed.

5. Were industrial hygiene data and historical data on use and repair of machinery and equipment obtained?

Historical exposures (Steenland et al. 1998) were estimated by combining an estimate of reduction in emissions from improved technology and fuels with the increase in emissions from the increased use of diesel engines and fuel. The reduction in emissions was taken from estimates made by Sawyer and Johnson (1995) of new engine particulate emissions for three broad time periods, the 1970s, 1980s, and 1990s. These data were incorrectly applied to the diesel truck fleet; because vehicle turnover time is long and particulate emissions increase with vehicle age, the fleet average emissions (which determine exposure) are always greater than the new engine technology. In-use truck emissions data are now available that could provide a better estimate of truck emissions (Graboski et al. 1998). Included are emission measurements from trucks that predate emission controls; these data could possibly be useful in establishing emissions relevant to the 1959–1983 exposures studied by Steenland and colleagues (1990).

6. Were personal exposure measurements obtained, and were they representative of the population studied?

The industrial hygiene study (Zaebst et al. 1991) provided information useful in identifying job categories in which teamsters might be at risk of exposure to diesel exhaust. Researchers developed a specific marker for diesel exhaust, EC_1, and demonstrated that ETS, a major source of respirable particle mass, did not interfere in its measurement.

The specific methods by which they selected breakbulk truck terminals and individual teamsters for air sampling were not described. The investigators appear to have collected a convenience sample rather than a random sample, so any inferences applied from these results to truck terminals and to teamsters across the country are uncertain. A statistically drawn sample from terminals and teamsters nationwide would have been desirable, although perhaps not feasible.

Individuals and sites were not sampled repeatedly, which makes it difficult to assess individual or fixed-site variability in exposure. Long-haul drivers in this study may not be representative of all such drivers, because only "short turn-around" drivers were sampled (drivers who returned to the originating terminal 10 to 12 hours after departing from it). Finally, the cut point of 10°C used in this analysis to represent climate effects on diesel exhaust exposure for teamsters is not well supported, and may introduce considerable uncertainty.

7. Were uncertainties in exposure assessment quantified?

The investigators used three different emissions models to represent changes in exposure over time, and they found that their primary conclusions did not change (Steenland et al. 1998). The major sources of error in estimating exposures to diesel exhaust have not been identified or critically evaluated. There is likely to be considerable uncertainty associated with the exposure categories into which workers were placed, and that uncertainty is likely to affect the findings of the case-control study as well as a QRA. The Panel did not extensively evaluate the assumptions in the report because of time constraints; however, this is an aspect that others can pursue.

OUTCOMES

1. Were outcomes defined in specific and objective terms?

The investigators clearly described the outcome as lung cancer identified on death certificates as an underlying or contributory cause of death.

2. Was the full range of outcomes included in cohort studies?

This is not applicable, because the teamster study was a case-control study of lung cancer.

3. Were participants actively followed to determine outcome status and the date outcome occurred?

This is not a cohort study. However, if personnel records or deaths of teamsters were missing from the Central States Teamsters Union files, results could have been biased. Information on the completeness of these files was not given in the original publication of the case-control study (Steenland et al. 1990).

ANALYSIS

1. Were analytic methods specified a priori?

There is no indication that the results obtained by using various exposure measures were explored before exposure-response analyses were conducted or that observed outcomes influenced the analyses.

2. Was the appropriateness of the statistical approach demonstrated and were potential biases explored?

Steenland and colleagues (1990) adjusted their statistical analyses by introducing categorical variables for age, race, smoking status, diet, and reported asbestos exposure. It appears that possible interactions among these variables were not investigated. All deaths occurred in 1982 and 1983, so there was no need to adjust for calendar year.

3. Were exposure-response relations statistically explored?

In the Steenland and colleagues (1998) analysis of an exposure-response association, average emissions per diesel vehicle were combined with historical information on heavy-duty truck VMT and the 1991 industrial hygiene measurements (Zaebst et al. 1991) to estimate past exposures for each job category. This assumption implies that estimating exposures in this way appropriately reflects exposures in the various job categories. However, the uncertainties of the assumptions involved were not adequately justified. Although the estimated exposures were reasonably proportional to fleet average emissions, it is not clear that they scale well with VMT, especially for off-road occupations. One might expect that the exposures of dock workers and mechanics would be independent of VMT, but related proportionally to the number of trucks coming to the dock and the number needing work by mechanics, if each truck driver is driving the same average distance per day. (The potential problems with the exposure estimation are discussed under Exposure Assessment, Question #4.) How the various assumptions regarding emission levels, timing of dieselization, and use of VMT interact and vary with, relate to, and affect the exposure-response analysis was not explored. It is possible that once the assumptions used to estimate exposure are reviewed and evaluated in the exposure-response analysis, the net impact of over- and underestimations will in fact be small; however, this issue needs to be explored. Figure 9 depicts the increasing use of diesel fuel as a fraction of all fuels used by vehicles since 1949.

To account for fleet turnover, the investigators conducted separate analyses with both zero- and five-year lags, and found similar results (Steenland et al. 1998). Actual fleet turnover time is likely to be much greater than five years, however; therefore, longer lag periods need to be explored. Steenland included a large number of covariates and reported goodness of fit of the final model, but effect modification was not explored. There is only limited discussion of how using other exposure-response functions might affect risk assessment, although the shape of the exposure-response function was evaluated in detail.

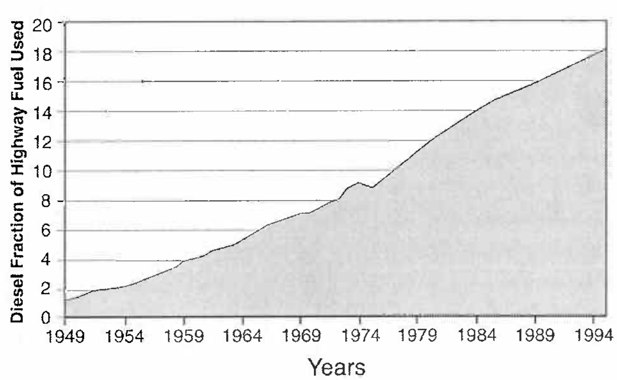

Figure 9. The increasing use of diesel fuel as a percentage of all fuels used by highway vehicles since 1949 in the U.S. (Adapted from Davis 1998.)

4. **Were uncertainties in risk estimates quantified, especially those resulting from exposure measurement error?**

The investigators discussed various sources of uncertainty, but did not evaluate them quantitatively, nor did they develop an overall quantitative estimate of uncertainty from all sources. How uncertainties in the emissions and exposure measurements propagate through the exposure model is complex, but methods exist to assess such uncertainty.

To a limited extent, the dependence of the estimated exposure-response relation on assumptions about the exposure model was explored by conducting analyses with increased exposures for long-haul drivers, and by using three assumptions about the decrease in emissions since 1970. The investigators' publication does not include analyses that fully reflect most potential biases and uncertainties in exposure estimates; however, it concludes with appropriate statements about the uncertainties in exposure estimates.

DISCUSSION OF USING TEAMSTER DATA FOR QUANTITATIVE RISK ASSESSMENT

The Panel concludes that a strength of the exposure-response analyses of the teamster data is in the apparent relevance of the diesel exhaust exposure levels to those of the general population (Zaebst et al. 1991), indicating that truck drivers are exposed annually to about 4 µg/m^3, roadside exposures are about 2.5 µg/m^3, and residential exposures are about 1 µg/m^3. The estimated annual exposure of long-haul truck drivers is not far above that of the general population. Heavy-duty trucks are one of the major sources of the general population's exposure to diesel emissions, so the assessment of risk for truck drivers is relevant to assessment of risk for the general population. Exposure assessment on the basis of elemental carbon provides a measure that is a reasonable marker for DPM, an improvement over previous assessments utilizing total respirable particulates.

The Panel believes that the assumptions used in the exposure assessment (Steenland et al. 1998) should be extended and validated, particularly to account for variations in diesel exhaust levels over time and improved estimation methods. The quantitative exposure portion of this study is new to the literature and, unlike the railroad worker studies, it has not undergone the extensive post-publication peer review that is required to develop a fuller understanding of the data. In fact, Steenland and colleagues (1998) concluded their findings by stating: "Our results should be regarded with appropriate caution because our exposure estimates are based on broad assumptions rather than actual measurements."

The Panel has some specific concerns regarding the exposure-response analysis assumptions and how the associated uncertainties in each assumption affect estimates of exposure. First, estimating exposure using previous 1990 emissions data may underestimate exposures given recent data from in-use vehicles that indicate emission levels of new diesel engines may in fact be higher than previous measurements made from an engine dynamometer, which were used in the study by Steenland and colleagues. Second, determining the onset of dieselization needs to be reconsidered because fewer diesel vehicles on the road in the early years would mean proportionally less diesel exhaust exposure during that time.

Third, the degree to which VMT accurately reflects the proportion of exposure for the various job categories needs more detailed exploration. More VMT by heavy-duty vehicles does not necessarily mean that exposures for dock workers and mechanics working on those trucks increase proportionately with the extra miles traveled. Instead, the VMT increase is likely to mean more dock workers and mechanics, rather than higher exposures per person.

Fourth, the analytic models did not explore the use of longer lag periods to account for the slow turnover of vehicles in use. A five-year lag is unlikely to be sufficient to account for fleet turnover, which may take closer to 20 years. Fifth, nondiesel sources of elemental carbon were not considered in the exposure assessment. Although elemental carbon from stationary sources may be decreasing in the air over time, recent findings indicate a substantial elemental carbon contribution from gasoline engines that should not be ignored (NFRAQS 1998). Finally, a background level of exposure was fairly similar to levels of exposure for the drivers, and sorting out the differences could be difficult.

The Panel speculated that controls selected for use in the case-control study of teamsters might have been biased in ways that could affect the findings. Exploring the distribution of causes of death among controls by smoking and exposure status could help clarify the possibility of selection bias and confounding in the data. Although no direct evidence of such bias is apparent, the Panel offers hypothetical examples showing the effect of potential bias in case-control studies with deaths from "other causes" (depicted as CVD because most of the "other causes" were probably CVD deaths) under different scenarios in Appendix D. Even though these examples suggest that case-control studies that use "other" causes of death could produce misleading results, it is important to note that they are only hypothetical examples. Whether or not such bias is present will require further examination.

The postpublication peer review of a potentially important study can be a long, laborious, and uncertain process. It took several years of work by both the original investigators and independent analysts to learn much of importance about the railroad worker study. This process can and should be accelerated for the teamster study, particularly given the apparent relevance of the data to ambient exposures. When reviewed by the original investigators and other analysts, these data may reveal new issues and raise new points for discussion in the scientific and risk assessment communities.

Findings and Recommendations for Future Research

The Diesel Epidemiology Expert Panel was charged to (1) review the epidemiologic data that form the basis of current QRAs for diesel exhaust, (2) identify data gaps and sources of uncertainty, (3) make recommendations about the usefulness of extending or conducting further analyses of existing data sets, and (4) make recommendations for the design of new studies that would provide a stronger basis for risk assessment. The Panel was not charged to evaluate the broad epidemiologic literature concerning exposure to diesel exhaust and lung cancer for hazard identification purposes. The Panel's review of the epidemiology focused on the railroad worker (Garshick et al. 1987, 1988) and teamster (Steenland et al. 1990, 1992) studies because these studies have been used or considered for use in QRA, and other epidemiologic studies did not have associated quantitative exposure data. The Panel also reviewed published exposure-response analyses of the railroad worker data (Crump et al. 1991; OEHHA 1994, 1998; Crump 1999) and teamster data (Steenland et al. 1998), along with published industrial hygiene studies (Hammond et al. 1988; Woskie et al. 1988a,b; Zaebst et al. 1991). The Panel's findings are based on examination of these studies only, and not on the entire epidemiologic literature in this area.

The Panel recognized that no epidemiologic study can be perfect. Therefore, the Panel viewed its task as addressing the question: To what extent can limitations in the design and performance of a particular study affect its contribution to the body of epidemiologic knowledge under examination for QRA? The Panel also recognized that frequently it is very difficult to obtain retrospective data for estimating job-related work exposures, and that this process may require assumptions that cannot be validated. In the studies considered here, which form the core of the Panel's review, investigators made reasonable attempts to reconstruct past exposures to diesel engine emissions, using approaches that were feasible when the studies were conducted. These data have subsequently been used, in some cases, for purposes that were not envisioned by the original investigators.

Evaluation, reanalysis, and scrutiny of research reports bring new understanding. This report, including the evaluation, findings, and recommendations, is not meant to be the "last word" in this matter. Instead, it is meant to inform HEI and others about data needs and future research directions, including where improvements can be made on the basis of what has been learned from the limitations of currently available studies.

Important work is currently under way to study the effects of exposure to diesel exhaust among nonmetal miners in Germany (Säverin et al. 1998) and in the United States (NCI-NIOSH 1997). These studies were not reviewed because they are still in progress. However, the Panel heard presentations from these investigators at the HEI Diesel Workshop: Building a Research Strategy to Improve Risk Assessment (HEI 1999) at Stone Mountain, GA, March 7–9, 1999. In particular, the NCI-NIOSH study is large and appears to be well designed and comprehensive. It includes a cohort and nested case-control component, as well as extensive measurements of current exposure to diesel exhaust, detailed reconstruction of historical exposure, and biomarker development. When completed, these studies are likely to inform hazard identification, exposure estimation, and exposure-response analyses, all components of risk assessments.

The Panel recognizes that regulatory decisions need to be made in spite of the limitations and uncertainties of the few studies with quantitative data currently available. The findings described here and the systematic evaluation of these studies are designed to provide a means to weigh a study's strengths and limitations and to inform the QRA process.

FINDINGS

GENERAL

Enhanced exposure and epidemiologic data and analyses are needed for the purposes of QRA; these might come from further exploration of existing studies or from new studies.

RAILROAD WORKER STUDIES

At present, the railroad worker cohort study (Garshick et al. 1988), though part of a larger body of *hazard identification studies, has very limited utility for QRA of lifetime lung cancer risk from exposure to ambient levels of diesel exhaust for the following reasons.*

- The various exposure-response analyses are limited by the scope and quality of currently available exposure data. Quantitative exposure data were not obtained during the cohort study period. Also, there is a paucity of qualitative data on individual exposures before 1959, and on the variation in exposure by railroad site, by season, and over time. The potential impact of concurrent exposures (for example, to grease, dust, other fumes, asbestos, and active and passive cigarette smoke) was not examined in depth. The diesel exhaust exposure data are suitable for a crude categorical measure of exposure by job category; but other measures, including duration of employment in a job category exposed to diesel exhaust, intensity of exposure concentration ($\mu g/m^3$), and lifetime exposure ([$\mu g/m^3$]-years), are not adequate to support quantitative exposure-response analyses.
- The Panel's analysis of the exposure-response association in the railroad worker data showed that the evidence for a positive association of lung cancer with cumulative exposure to diesel exhaust depends entirely on differences in risks among job categories. Train workers (with higher exposures) have higher risks compared with clerks (with low or no exposure). However, within all job categories, the relation of lung cancer risk to duration of employment is negative.
- Factors that might explain a negative association between duration of employment and lung cancer in these data include bias introduced by systematic differences in exposure misclassification among and within job categories; differentially incomplete ascertainment of lung cancer deaths by job category; lack of information on other occupational exposures and air pollutants; the presence of a healthy worker survivor effect; confounding by cigarette smoking; and analysis of relative risks rather than absolute risks. Also, in a case-control study, if causes of death among controls were associated with exposure to diesel exhaust, smoking, or both, the results could be biased.

TEAMSTER STUDIES

The investigators' analysis of the teamster data reported an exposure-response relation (Steenland et al. 1998) that may be useful for QRA; this relation will be better understood with further exploration of uncertainties and assumptions, particularly those relating to the reconstruction of past exposures and the selection of controls. Exposures of teamsters are more similar to ambient exposures of the public than are exposures of railroad workers, and the diesel exhaust to which teamsters are exposed comes from a source that is likely to be relevant to regulatory issues.

The Panel reviewed the teamster study without the benefit of additional analyses and interpretations, and its comments are not as detailed as those about the railroad worker studies. Understanding the teamster study will evolve with time; however, some conclusions can be drawn now.

- The set of teamster studies may provide reasonable estimates of worker exposure to diesel exhaust, but significant further evaluation and development are needed. The marker for diesel exhaust that was selected for study by Steenland and associates, EC_1, is more sensitive and specific than RSP adjusted for environmental tobacco smoke, but has several limitations (e.g., the contribution of diesel emissions to ambient EC_1 concentrations has not been constant over time). The industrial hygiene study, which was conducted after the period when workers in the case-control study were exposed, identified a range of exposures for various job categories, but did not consider (1) site-to-site variations, (2) seasonal variations, (3) concurrent exposures to other agents, (4) historical ambient particle concentrations, or (5) intra- and interindividual variability. The estimation of historical exposures needs to incorporate recent data on diesel emissions from vehicles in use, reassessment of when dieselization occurred, alternatives to estimating exposure by vehicle miles traveled, and historical regional ambient pollution data.
- The exposure-response relation reported in the teamster study increases in a linear manner. However, more can be learned from other analysts examining these data using different approaches.
- Neither a roster of the study population nor an alternative method of selecting controls to represent it was available to the researchers. It cannot be established with certainty whether the causes of death used for controls adequately represent the joint distribution of exposure to diesel exhaust and smoking in the case-control study. If smoking, or diesel exhaust exposure as determined by job category, or both were associated with causes of death used for controls, results could be biased.

RECOMMENDATIONS

The Panel's recommendations reflect its general understanding, as expressed in its framework for evaluating studies, of what constitute adequate data for QRA. They also reflect the preceding evaluation of the studies of railroad workers and teamsters. The Panel is aware that research currently in progress will respond to some of these research needs; however, results are not yet available, and it is not yet clear whether all of the proposed needs will be met.

COMPLETED STUDIES

1. The Panel recommends against using the current railroad worker data as the basis for QRA in ambient settings.
2. Further scrutiny of the teamster data, including estimation of uncertainty in both the exposure estimates and selection of controls, is recommended in order to improve the use of these data in QRA. Strengths of the teamster study include the relevance of exposure levels to the general population and the use of an exposure marker for diesel engine emissions that was an improvement over RSP. The teamster study exposure-response analysis is relatively new, and its further review and analysis by both the original investigators and others should be accelerated. Alternative retrospective exposure models need to be developed that use the alternative assumptions described above and in more detail in the body of the text.

NEEDS FOR NEW TECHNIQUES AND DATA

3. Better measures of exposure to constituents of diesel emissions, with careful attention to selection of the sample studied, are needed. Of particular importance are the selection and validation of a chemical marker of exposure to the complex mix of diesel exhaust emissions. Exposure models may include data from personal monitors, area monitors placed where diesel exposure is likely to occur, and current and historical data regarding emission sources. In any such modeling effort, the effects of environmental tobacco smoke should be removed as completely as possible.
4. Reliable estimates of past emissions and of factors affecting historical exposures in a range of settings are needed to improve the characterization of uncertainties, both quantitative and qualitative, in historical models of exposures.
5. Although biomarker technology was not available when the studies reviewed were conducted, appropriate, validated, and specific biomarkers of diesel exposures, health outcomes, and susceptibility are needed.

DESIGN NEEDS FOR NEW STUDIES OF EXPOSURE-RESPONSE ANALYSES

6. Exposures should be adequately and accurately characterized with respect to magnitude, frequency, and duration, rather than solely by duration of employment. Errors and uncertainties in exposure measurements should be quantified where possible; these should be fully reported to users, and taken into account in both power calculations and exposure-response analyses.
7. Cigarette smoking is a potent risk factor for lung cancer, and it must be controlled for in any study of risk factors for this disease. Smoking histories obtained for a cohort study subset that uses a case-control or case-cohort design will strengthen the interpretation of results.
8. The exposures considered should be close to levels of regulatory concern, including a range of exposures to provide a base for understanding the relation between exposure and health effects.

NEEDS FOR NEW STUDIES

A prospective epidemiologic study of the development of lung cancer in exposed and unexposed individuals could have many strengths. Information on confounders and exposures could be more complete than for a retrospective study, and many of the biases and uncertainties discussed in this report could be eliminated or reduced. These advantages, however, need to be weighed against the disadvantages, which include high costs and a long period of follow-up. Other study designs that include retrospective components, are possible for a new epidemiologic study of lung cancer, but they are likely to include uncertainties and sources of bias that investigators will need to explore completely and acknowledge in their reporting.

9. The Panel recommends that a new, large, epidemiologic study of diesel exhaust emissions and lung cancer be considered after (1) currently ongoing or existing studies, including HEI's feasibility studies (to be completed in the spring of 2000), are evaluated, and (2) attempts to retrofit improved exposure assessments to existing epidemiologic studies are evaluated, including whether they can provide sufficiently accurate, complete, and relevant exposure data to support QRA.
10. Studies of lung cancer risk in general populations exposed to ambient diesel exhaust particulate matter will be difficult to conduct; however, such studies could usefully investigate other, noncancer health effects that occur in a shorter time after exposure.

Appendices

Appendix A. Diesel Epidemiology Expert Panel Workshop

WORKSHOP AGENDA FOR APRIL 20, 1998

Introductory Remarks *John Bailar* and *Kathleen Nauss*

Summary of the Design and Results of the U.S. Railroad Worker Studies and Issues Raised Using These Data for Dose-Response Analysis *Eric Garshick* and *Thomas Smith*

Questions on the Study Design and Results of the Railroad Worker Study

Analyses of Dose-Response Based on the U.S. Railroad Worker Cohort Study

- Discussion of Key Assumptions and Main Findings of Original Analysts *Kenny Crump* and *Stanley Dawson*
- Questions for Drs. Crump and Dawson
- Perspectives of Other Analysts *Duncan Thomas* and *Suresh Moolgavkar*
- New Analyses *Leslie Stayner* and *Dale Hattis*
- Questions for Drs. Stayner and Hattis

General Discussion of Approaches for Developing Dose-Response Estimates for Diesel Exhaust and Lung Cancer Based on the Railroad Worker Studies

Alternatives to the Railroad Worker Studies: U.S. Truck Driver Studies *Kyle Steenland*

- Questions and Discussion of Truck Driver Analysis

General Discussion

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Appendix B. Framework for Systematically Evaluating Epidemiologic Studies for Quantitative Risk Assessment

The Panel developed a framework of epidemiologic principles, with a focus on exposure assessment, for the systematic evaluation of the strengths and limitations of the railroad worker and teamster epidemiologic studies. It designed a set of questions representing an ideal research strategy, and emphasized that a "perfect score" was not the objective. The Panel did not assign overall priorities to these principles, because insisting that any one be given absolute priority over another may interfere with efforts to manage or address other principles in a more balanced fashion.

The Panel recognized that others have written on the use and limitations of epidemiologic studies for QRA (Gordis 1988; Hertz-Picciotto 1995; Samet et al. 1998). However, it chose to develop this series of questions in order to address specifically the issues it believed would be most relevant to systematic assessment of gaps in current knowledge that might be filled by future research efforts. The Panel also recognized that few, if any, epidemiologic studies are designed specifically for QRA, and the framework allows potential users of available studies a somewhat parallel approach to evaluating the strengths and limitations of each. This Appendix offers details and some rationale for including each of the items within the framework.

This framework also provides some basic concepts of epidemiology for readers unfamiliar with such material. For a more complete understanding of epidemiologic study designs and methods, several general texts in epidemiology are available (Monson 1980; Schlesselman 1982; Checkoway et al. 1989; Hulka et al. 1990; Selvin 1991; Gordis 1996; Kelsey 1996; Rothman and Greenland 1998). The Panel assumed that any epidemiologic study would follow standard epidemiologic practices as discussed in these texts.

DESIGN

1. **Was the study design efficient, and did it specifically consider power, potential types of bias, and latency?**

Epidemiologic studies need time to recruit subjects, an adequate latent period for the health outcome of interest to develop, and sufficient time for the accrual of substantial follow-up during any period of elevated risk. Study design considerations include cohort and case-control designs, the choice of study population, and the selection of controls. An efficient study design that allows more detailed characterization of exposure in all or a subgroup of the cohort, as well as collection of personal data such as smoking history, generally may be useful for a QRA. A simple design is the nested case-control study, but more complex designs also merit consideration. Although these efficient designs allow collection of details that might be otherwise unattainable, epidemiologic studies without them can still be useful in QRA.

Determination of the statistical power needed to address questions of interest is an important aspect of study design; adequate power for analyses of subgroups within the population also needs consideration. The design, including sample size, must make adequate allowance for factors that reduce power (such as losses to follow-up and uncertainties in exposure measurements) and at the same time minimize potential biases. If the sample size is insufficient, statistical power is low and the association under investigation is unlikely to be detected. It is useful to calculate the statistical power for detecting effects of various magnitudes, and to indicate the precision with which effects can be estimated, including the size of the effect that might be excluded (upper confidence limit). Exposure measurement errors, which can reduce both power and estimates of precision, need to be taken into account. Reasonable assumptions about latency are a part of most power calculations. For cohort studies, it is desirable to present power as a function of the duration of follow-up. Cohort studies that continue follow-up as long as subjects provide usable new information can be particularly beneficial to QRA.

The study design should reduce or control for several important biases including confounding, information bias, and selection biases. The contribution of an individual epidemiologic study to the body of literature for hazard identification depends on whether the statistical power of the study is sufficiently large to detect an effect and provides a degree of precision to that estimate as indicated by the width of the confidence interval. It also depends on whether the study design, data collection, and statistical analyses have reduced the potential sources of bias.

Confounding is a form of bias that occurs when a factor is associated with both the exposure and the outcome of interest. This factor is referred to as a confounding variable or confounder. In studies of lung cancer associated with exposure to diesel exhaust, the potential confounders of importance include age, cigarette smoking, ETS, asbestos exposure, other occupational exposures, and possibly nondiesel outdoor air pollution, but only if the factor is related to both diesel exposure and lung cancer risk. The effects of demographic variables such as age can generally be removed during the analysis, but adjustments for variables such as smoking and exposure to asbestos are not possible in the absence of adequate data on these factors. Information on the degree of possible confounding sometimes can be gleaned from considering causes of death other than the one of primary interest.

The direction of the effect of confounding depends on the directions of the associations between the confounder and the exposure, and between the confounder and the disease. Cigarette smoking, for instance, is widely acknowledged to be positively associated with lung cancer. Thus, if smoking is more common among persons exposed to diesel exhaust than among unexposed persons, the confounding would lead to overestimation of the risk of cancer associated with diesel exhaust. Conversely, if the group exposed to diesel exhaust smokes less than those unexposed, the confounding would lead to underestimation of risk.

Information bias refers to differential errors in measurement of exposure, outcome, or confounder information between groups being compared. For example, if the extent of information available or obtained for exposed persons differs from that for unexposed persons, an information bias would occur.

Misclassification is another form of potential bias in epidemiology that occurs, for example, when a control subject in fact has the outcome of interest. Misclassification can be either differential or nondifferential. In differential misclassification, the rate of misclassification differs by study group; for example, the fact of exposure may be wrong more often for cases than for controls. Nondifferential misclassification is the inaccurate classification of exposure or disease that is not dependent on any factor, such as case or control status. Differential misclassification can bias the estimate of risk in any direction, but nondifferential misclassification most often leads to an overall underestimation of effect. Some forms of misclassification can distort the shape of the exposure-response curve.

Selection bias results from a systematic difference in characteristics of subjects included in a study and is most likely to occur when choosing controls for case-control studies. Selection bias also is possible in cohort studies if, for instance, a cohort is assembled in such a way that completeness of follow-up for lung cancer differs by exposure. (Refer to Appendix D for further discussion of this matter.)

Submittal and selection of a study for publication in a journal, as well as the failure of a study to be published, can result in a form of selection bias. Editors as well as investigators often are reluctant to publish results that do not appear to show an effect, and they are extremely reluctant to publish results that appear to show implausible associations (such as inverse associations between exposure and health outcome). In a research field consisting of dozens of studies, however, a few such results are inevitable.

It is well established that persons in the work force tend to be "healthier" than persons not employed, and therefore healthier than the general population. Worker mortality tends to be below average for all major causes of death. Mortality in the general population thus is generally not a suitable standard for comparison in occupational studies, and can lead to biased findings. Because of this "healthy worker effect," investigators often compare morbidity or mortality of heavily exposed workers with workers in the same industry who have little or no exposure.

Some investigators also have reported a "healthy worker survivor effect" (Arrighi and Hertz-Picciotto 1994), in which mortality of long-term employees in some occupations is less than in those with shorter employment duration. This may seem counterintuitive because, if an association exists, one would expect mortality to increase with longer employment, which then becomes a surrogate for both age and accumulated exposure. Reasons for this survivor effect are not clear, but may include early demise or departure from the work force of some susceptible individuals.

The study design chosen needs to allow for an adequate latent period for developing the health outcome of interest after exposure to the risk factors studied. For some cancers, the latent period may be 20 to 40 years (Cold Spring Harbor Laboratory 1981). Latency period, timing of exposures, duration of exposures, and exposure-response measures are all interlinked, and all are essential to a complete assessment of risk. Exposure duration might provide a reasonable surrogate for exposure, although the investigator might not have data to convert duration into units of exposure. An additional limitation of this approach is that exposure duration does not reflect any variation of the intensity of exposure with time or among subjects.

Addressing the biases above strengthens a study's possible contribution to both hazard identification and QRA.

2. Were adequate quantitative exposure and covariate data planned and collected?

The Exposure Assessment section below has more details on exposure assessment and data collection. Exposure data generally are collected as part of epidemiologic studies, but the degree of quantification of exposure varies. Crude exposure distinctions can be adequate for some purposes, such as hazard identification, but detailed planning for collection of quantitative exposure data is particularly important if a study is to be used for QRA. The exposure assessment plan also informs the analytic plan.

Planning to include data for each study subject with accurate information about the primary exposure of interest, as well as exposure to other known and suspected risk factors, is optimal. In occupational studies without individual monitoring, surrogate measures or markers to estimate exposure can provide useful information. A range of exposures is needed if effects of different magnitude, duration, or frequency are to be compared.

It is important that the study design consider incorporating the variability of personal exposure over time, including multiple samples for the same individual. To the extent that the study design limits exposure measurement for a subsample of the population, it is important to demonstrate that the individuals selected for monitoring reasonably represent the range of activities, behaviors, and exposures of the study population for which the exposure is assessed retrospectively. Exposure data that include the range relevant to regulatory decision-making would be particularly useful for QRA.

3. Was the literature reviewed for relevant study methods and previous research findings?

The literature review can serve to refine and focus a study's hypotheses, support study design decisions, explain analytic approaches, evaluate exposure measures, define the outcome of interest, and identify questions that remain to be answered. A QRA will raise specific issues about exposure measurement, analytic techniques, and outcome measurements that go beyond what is included in the reports from most epidemiologic studies. The literature review needs to specifically address these QRA issues. A thorough review of the literature regarding a possible hazard includes a critical analysis of all epidemiologic studies concerned with the suspected hazard, and a summary of relevant animal studies, exposure studies, and case studies. Information on possible biologic mechanisms of action or variations in individual susceptibility is also important. A summary of the literature surrounding other known and suspected risk factors for the outcome of interest, as well as a summary of current issues within the research topic, can be useful. If unusual, recent, or critical methodological issues are of importance to the area of research, a summary of the pertinent literature also can be useful.

4. Were plans made for postpublication data scrutiny?

While a study is under way, interim reports, scientific critiques midway through the study, and periodic external independent reviews can provide the investigator with useful feedback. After publication, although not an epidemiologic principle, sharing copies of the data and related documentation with colleagues can assist the scientific community and regulatory agencies in understanding the details of a particular study, and can provide a scientific "second opinion" that further evaluates the pertinent issues in an objective manner. Sharing data with other investigators for reanalysis can allow other analytic approaches to be developed, which can be particularly important when published studies do not produce a clear consensus about the magnitude, or sometimes even the direction, of an effect. Such postpublication analyses are most effective when both the original investigator and the recipient of this information hold to the highest standards of collegiality, ensure the integrity of any promise of confidentiality of study subjects, and respect each other's intellectual property rights. The original investigators should have some rights in these circumstances to see any results of further analyses before they are made public.

EXPOSURE ASSESSMENT

1. Were detailed lifetime histories of occupational exposures collected?

Quantitative measures of exposures are important in any epidemiologic study used for QRA. The greater the detail regarding specific exposure, including how much, for how long, and at what concentration, the more useful the study is for this purpose. Frequently, however, individual measures of exposure are not available, and surrogate measures or markers of exposure are used. For example, the most general surrogate measures of exposure in occupational epidemiologic studies are job classification and work location. Starting with a standard classification scheme for job and work location generally is preferred, unless there are specific reasons to replace or supplement the standard with an ad hoc classification. Standard schemes include the U.S. Census Bureau Classified Index of Industries and Occupations, the U.S. Labor Department Dictionary of Occupational Titles and Definitions, and the U.S. Office of Management and Budget Standard Industrial Classification and Standard Occupational Classification. These standard codes can be grouped according to possible exposures. The advantage of beginning with the standard classification systems when quantitative exposure data are not available is that many published mortality studies use such systems, and can provide a basis for comparison. A description of job duties frequently can refine industry and job titles.

Information on the magnitude, frequency, and duration of exposures within each job is desirable and preferable to duration only, but is often unavailable. In many occupational studies, the only exposure information available is duration of employment in specific jobs, which provides a poor estimate of exposure. Thus, the exposure scale in exposure-response analyses of such studies is essentially a detailed analysis of duration of employment. In addition, risk can be related to duration of employment for reasons other than the exposure of interest, thus biasing the exposure-response relation; an example is concurrent exposure to other possibly toxic agents.

The goal of a QRA for regulatory purposes is to estimate an effect of lifetime exposure to the agent of interest. Uncertainties are introduced when exposure magnitude, frequency, and duration are not quantified among job categories; when individual exposure varies primarily because of differences in exposure duration within job category; or when exposures in all of the job categories examined are similar. Although measures of cumulative exposure, which depend on exposure duration, are important for QRA, a study is more informative if available exposure data also allow the effects of exposure intensity and duration to be evaluated separately.

2. Were known chemical and physical characteristics of the main exposure specified?

A detailed characterization of the sources of an agent, valuable to understanding the main exposure of interest, would include specific information (chemical and physical characterization) on the nature and source of the exposure, historical trends, aspects of source use that affect the exposure, and the factors that control transport and transformation of the emitted contaminants indoors and outside. Mixtures of substances are particularly difficult to characterize because they may vary from time to time and place to place in ways that may be difficult to document.

3. Were potentially confounding exposures measured or estimated?

The main exposure of interest often is not isolated in the environment where subjects are exposed. That is, subjects are likely to be exposed to additional agents that may confound or modify the association under investigation; for example, smoking or exposure to ETS would be such factors in many studies.

Some studies of occupational exposures have investigated confounding by smoking. Results have been mixed—some produce evidence of confounding and some do not. A nonsignificant *p* value does not demonstrate that no confounding occurred, though confidence limits on a confounder effect might provide useful information about the greatest degree of confounding that would be generally consistent with the data. For example, smoking might not appear to be a confounder for a particular occupational exposure, but a study is open to criticism if no smoking data are collected and the association between exposure and outcome is weak. In addition to being a confounder, smoking may be an effect modifier, in that the estimated increase in risk of lung cancer from diesel exhaust may differ between smokers and nonsmokers. Smoking data are necessary to allow effect modification to be investigated.

Measurements of confounders are needed to understand their potential effects on the analysis of the exposure of interest. Failure to account for possible confounding or effect modification by other exposures might mask a real (positive or negative) association. When the magnitude of the association of interest is weak, uncontrolled confounding, particularly from a strong confounder such as cigarette smoking, can have a major impact on the study's results and on the credibility of their use.

4. Were magnitude, duration, and variability of exposure determined?

Studies with quantified individual exposure data contribute more to a QRA than studies without such data. Because personal exposure varies over time, sampling the same individual multiple times to capture various seasons, activities, and work place settings is preferable to obtaining a single sample. Multiple measurements during episodes of peak exposure, as well as collecting data for subgroups of interest, are often important.

Historical or current source emission data, when combined with factors that govern the dispersal and removal of contaminants in the environment (meteorological variables, ventilation, dry or wet deposition, chemical transformations, etc.), can be modeled to assess air contaminant concentrations in particular air environments, which in turn can be used to assess individual or group exposures over time. Air contaminant measurements that have been made in several different environments can be used to assess such exposures directly. If an historical record of environmental measurements exists, past exposures associated with a particular environment can be assessed. Estimates of total exposure can be based on either measured or estimated concentrations within each outdoor or indoor environment, combined with time-activity observations or questionnaire data. Uncertainty is associated with using environmental measurements to assess exposure, however, and the source and magnitude of that uncertainty needs to be specified.

5. Were industrial hygiene data and historical data on use and repair of machinery and equipment obtained?

A critical review of the historical records on the nature and chemical characterization of exposure and environmental monitoring data can add to the exposure assessment and improve historical reconstruction estimates. In addition to historical records of measured exposures (specific to an employer), records on the purchase and maintenance of equipment, the industrial processes resulting in exposure, and repair shop operations can provide information to help define historical exposure levels and trends by industry.

6. Were personal exposure measurements obtained, and were they representative of the population studied?

Personal monitoring for inhaled exposures is conducted using either passive (diffusion) or active (pump) samplers worn in the breathing zone to measure exposure to contaminants of interest as people go about their daily activities. Subjects typically wear the monitors for periods of a few hours to several days to provide an integrated measure of exposure over space and time. Personal monitoring can reduce some of the uncertainty in exposure assessment; however, continuous monitoring cannot distinguish among exposures that occur in different indoor and outdoor environments or among different activities in which the subjects are involved.

It usually is not practical or cost-effective to conduct personal monitoring on all subjects. Supplementary questionnaire-derived information, environmental models, and daily activity diaries usually are needed to estimate the contribution of specific environments, activities, or sources to the total exposure.

Special care must be taken in selecting a sample of subjects for personal monitoring because exposures may vary widely within job categories and for an individual over time. A random sample of subjects can be selected in various ways to ensure that it is representative of the entire population under study (e.g., a simple random sample of individuals, stratified sampling based on job environments or job categories, random cluster sampling). Nonrandom samples, especially convenience or quota samples drawn to address specific questions, are sometimes useful but always difficult to interpret, and they produce results of greater uncertainty than properly designed random samples. The process used to select the sample and to document that it is representative of the study population need to be stated clearly and in some detail, especially for nonrandom samples.

7. Were uncertainties in exposure assessment quantified?

Exposure assessment should include quantification of the uncertainty in each aspect of the assessment, as well as the overall uncertainty in estimates of exposure. These uncertainties are likely to vary among subjects (or categories of subjects). Sources of uncertainty that are the same (or strongly correlated) for subjects within a category should be separated from sources that are independent. For many components of the exposure assessment, quantitative estimates of uncertainty are necessarily based on subjective judgments. To ensure that the resulting evaluation of uncertainty is useful for interpreting the exposure-response analyses, it is suggested that exposure assessors work closely with the epidemiologists and statisticians analyzing the epidemiologic data. (Refer to Analysis Question 3 below.)

OUTCOMES

1. Were outcomes defined in specific and objective terms?

Criteria for health outcomes in a study are less subject to bias if the definitions are accurate, specific, attainable, and as objective as possible. A study is less likely to be biased if the outcome is not subject to possible misclassification. For example, the operational definition for cancer can be a tissue specimen or pathologic diagnosis (most accurate), a clinical diagnosis (less accurate), or a death certificate (least accurate).

2. Was the full range of outcomes included in cohort studies?

Cohort studies rely on various sources of information and record-keeping systems to define and identify subjects having the outcome of interest. A by-product of this is obtaining information about a range of other health conditions. For example, if death certificates are examined for a possible relation between some exposure and death from a particular cancer, the certificates of all deceased subjects must be searched to find those that report the cancer. With little additional effort, the full range of causes of death can be examined. Relevant information on death certificates may include any underlying causes of death, as well as the primary cause of death.

3. Were participants actively followed to determine outcome status and the date outcome occurred?

A clear statement of the cohort follow-up methods is needed. Active follow-up of study participants to determine their health outcome and its date, as well as the determination of a subject as "outcome free," or the date a participant was last known to be "outcome free," can be important for reducing bias. Active follow-up strengthens a study's findings because confirmation of the outcome is sought, and the information acquired is more complete and generally less biased than with passive follow-up. Subjects determined to be "lost to follow-up" are usually assigned a date corresponding to the last date they were confirmed to be "outcome free." If the follow-up is passive, subjects not identified as having the outcome are generally assumed to remain "outcome free." For example, absence of a claim for death benefits may not be adequate evidence that the study subject is still alive. In this situation, a special small study might be undertaken to estimate the number of outcomes that were missed by passive follow-up.

If the percentage of follow-up completed is high, bias tends to be reduced. If a significant number of participants are nonrespondents or lost to follow-up, results can be questionable because of possible misclassification biases, and the number of subjects with unknown outcome may be sufficiently great that the validity of the study findings is questioned.

ANALYSIS

1. Were analytic methods specified a priori?

A study protocol commonly specifies the fundamental hypotheses, but it is equally important to specify the primary methods of analysis the investigators plan to use. Additional analytic techniques, especially those suggested by the data, can supplement the primary methods of analysis, but they lack full statistical justification. A general concern is that analytic methods not specified a priori may be chosen to emphasize some aspect of the findings and, therefore, bias the results. An example would be performing multiple statistical tests of variations and reporting only the most extreme *p* values.

The statement of primary analytic methods specifies the general analytic approaches, software packages to be used, cut off points for continuous variables, exposure metrics, methods of adjustment for age and other confounders, subsets of the data to be analyzed, and exposure-response models.

Exposure data may include several types of measurements, and several possible approaches are likely for assigning exposure estimates to individual subjects. Although analyses based on more than one approach can be informative, it is important to specify the primary exposure metrics before the exposure-response relation is examined.

Defining group categories from continuous data is also important, and these categories should be specified in the protocol rather than determined on the basis of statistical significance levels after the data have been obtained.

2. Was the appropriateness of the statistical approach demonstrated, and were potential biases explored?

An early step in the analysis is to evaluate the appropriateness of the statistical methods specified in the protocol for the primary analyses. This usually involves comparing the fits of various models to establish that analyses based on the model selected do not seriously distort results. The specifics of this evaluation vary from study to study; discussion of a few common types of assumptions follows.

Because lung cancer risk depends on gender, age, calendar year period, and smoking habits, and because estimates of exposure might also vary by these factors, it is important to provide adequate control for these factors in developing quantitative risk estimates. Age and calendar year period can be related strongly to cancer risks as well as to many other health endpoints. In studies (such as occupational studies) in which exposures accumulate over time, exposure also is likely to be related to age and calendar year period. For this reason, analyses need to provide tight control for these variables, and use minimal assumptions regarding the form of their relation to risk of disease. Less flexible models (for example, those that treat age or calendar year as continuous, linear, or exponential variables, or do not include interaction terms) can be considered, but only if it has been demonstrated that they provide an adequate fit to the data.

Analyses are often based on the assumption that the relative risk is constant across strata. This assumption can be evaluated by fitting models that allow relative risks to vary by factors such as age, calendar year period, gender, and time since initial employment. Differences in relative risks might simply reflect differences in the magnitude of exposure; alternatively, other factors may modify sensitivity to a specific exposure. This modification of risk can be important in analyses that quantify the relation between exposure and risk (for example, by estimating the risk per unit of exposure). Risks can be compared among subgroups defined by these variables to investigate these dependencies, or parameters can be introduced to estimate and test the dependencies, or both. However, statistical power and precision for adequately evaluating modifying factors are often limited. Also, whether a factor is considered to modify the risk depends on the metric of risk. For example, if relative risks for lung cancer are similar for smokers and nonsmokers, absolute risks for the two groups can differ substantially.

Absolute risk models often are more difficult to fit; however, they give a direct measure of impact and, therefore, their wider use is suggested. Neither a relative risk model (and its surrogate, the odds ratio) nor an absolute risk model might mirror the biological situation; there is little reason to expect nature to follow any predetermined mathematical structure. Many statistical modeling approaches are available, and the discussion here is not meant to be inclusive. Other types of models, such as nonparametric models (including Kaplan-Meier plots), multistage models of carcinogenesis, or other biologically based models might also be appropriate to consider. However, in the absence of an understanding of the mechanisms for exposure-related carcinogenic risk, it may be difficult to interpret the results of multistage models or other biologically based models. Even when the fit is good, such models generally should be reported as approximations. If evidence of substantial variation is found, it is especially important to fit models that allow for this variation and to present separate results for various subgroups of data.

3. Were exposure-response relations statistically explored?

The exposure-response relation is important to the development of a QRA. In the analysis, the investigators may explore the shape of the relation (e.g., linear), possible modifying factors, and alternative measures of exposure.

Flexible models permit a better understanding of the possible relation between exposure and health outcome. This understanding is valuable for estimating the impact of a particular exposure on a population's health both present and future, as well as for the risk estimation needed to assess and control occupational and environmental hazards.

The effect of a given exposure on risk is likely to depend on the length of time that has passed since the exposure occurred. First, for example, recent exposures are not likely to have affected the risk of diseases with a long latent period (e.g., cancer), so it is often desirable to exclude exposure received during some specified period before the time at risk, known as the lag period. The lag period need not be the same for all endpoints. Even if the protocol has specified lag periods, it is desirable to evaluate their appropriateness by conducting analyses based on alternative lag periods. Second, to evaluate more completely the effect of time since exposure, it might be desirable to include separate variables for the effects in each of several "windows" of exposure (for example, categories of time since exposure such as 5 to 15, 15 to 25, and 25+ years), or to use continuous variables to examine a change in risk with time since exposure. Measures that weight exposures in the various "windows" might also be considered. Third, exposures that vary from time to time, or from one person to another in the same category, may be weighted to reflect actual exposures, but this requires data that are rarely available.

If a specific exposure-response model is proposed (such as a linear model), the assumption of the proposed response form also needs validation. This can be accomplished by comparing the fit with more general parametric models or categorical models. For example, the fit of a linear model can be compared with the fit of a linear-quadratic model or a model in which the risk is related to an estimated power of the exposure.

Often more than one approach is available for defining the exposure metric to be analyzed. Most studies can benefit from collaboration among the data analysts and the persons assessing exposure. Factors to consider include possible bias and uncertainty in the proposed metric and the ability of the metric to discriminate among subjects. The final choice can involve a trade-off of these factors. In an occupational study, for example, duration of employment might be estimated accurately, but exposures among subjects with similar employment duration cannot be differentiated. Measures that use industrial hygiene data to assign quantitative measures to various job categories provide better discrimination among subjects, but are likely to be subject to large uncertainties. Several exposure measures for each subject can be computed and examined for variability and the degree to which they are correlated.

4. Were uncertainties in risk estimates quantified, especially those resulting from exposure measurement error?

Exposure estimates are subject to both systematic bias and random errors. Systematic bias in exposure estimates can affect risk estimates that are expressed per unit of exposure. Random errors in exposure estimates also can result in bias. In general, random errors bias estimated regression coefficients toward the null, although this may not necessarily be true in the special case in which the only error is the substitution of group means for individual measurements (Berkson error). Random errors can also result in both underestimation of uncertainty and distortion of the shape of the exposure-response curve. Statistical analyses can take into account the uncertainties in exposure estimates; however, this is often difficult or impossible in practice, in part because statistical methods for doing so are complex (possibly requiring extensive software development), and in part because it is difficult to quantify potential bias and uncertainty.

Fairly simple procedures sometimes can provide at least some information on the sensitivity of analyses to uncertainties in exposure estimation. One such procedure is to conduct restricted analyses that exclude subjects or job categories thought to have exposure estimates that are especially uncertain or particularly subject to bias. Another is to restrict analyses to workers initially employed after some specified date when exposure assessment is thought to have become more adequate.

Methods for accounting for random errors have been developed, but these procedures are often difficult to apply and can require computer simulations. They also require knowledge of the nature and magnitude of exposure measurement errors, including the extent to which errors are correlated among subjects. Application of such methods might be important even when they are based on overly simple assumptions; sensitivity analyses can then be conducted under several alternative assumptions. Such analyses do not decrease the uncertainty resulting from imperfect dosimetry (only improvements in dosimetry can do that), but they can provide an assessment of the additional uncertainty in the estimated exposure-response relation resulting from this problem.

Sampling error is another source of uncertainty in risk estimates. Confidence intervals and *p* values that describe this uncertainty often are based on the assumption that various statistics follow normal (Gaussian) distributions. Statistical theory provides assurance that this assumption is appropriate provided the sample size is sufficiently large. However, exposure distributions are often highly skewed (nonnormal), and analyses can be affected strongly by a small excess of observations in higher exposure categories. In this situation, the assumption of normality might not be adequate or appropriate. Although they are computationally more cumbersome, *p* values and confidence intervals based on a likelihood ratio statistic often provide better approximations of uncertainty than other approaches (such as the use of the asymptotic standard error). Software that allows reasonably easy implementation of this approach is now available. In some cases, exact methods or computer simulations can be considered.

Appendix C. The Panel's Exploration of Railroad Worker Data

This appendix describes results of the Panel's examination of certain aspects of the original railroad worker data, as presented by Garshick and colleagues (1988). These analyses were undertaken to assist the Panel in evaluating the usefulness of the data for QRA, to help clarify reasons for differences in results obtained by other analysts, and to verify and better understand these other analyses. The Panel's analyses were limited to these objectives, and were not intended to explore or evaluate completely the railroad worker data or to provide a model for QRA. This discussion of results and stated conclusions describes the Panel's findings from its analysis in conjunction with its review of the relevant literature.

DESCRIPTION OF THE DATA

Dr. Eric Garshick provided the basic data in the form of computer records on over 55,000 railroad workers. The Panel used the DATAB module of the software package EPICURE (Preston et al. 1991) to collapse data into cells that contained person-years of exposure, and numbers of deaths from all causes and from lung cancer. Deaths from lung cancer were defined as those where the underlying cause was coded ICD 162.0 or 162.1. Categories of cells included single calendar years (1959 through 1976), attained age in five-year intervals to age 80, and age in 1959 in five-year intervals. A few lung cancer deaths over age 80 and the associated person-years of follow-up were excluded because of a concern about the quality of death certificate information in this age group. The last four years of follow-up (1977–1980) were excluded because follow-up appeared to be incomplete during this period (Crump et al. 1991; Garshick 1991).

Duration of exposure to diesel exhaust (which was duration of employment) was categorized into 12 intervals (in months: 0–29, 30–44, 45–59, 60–74, 75–89, 90–109, 110–129, 130–149, 150–174, 175–199, 200–224, 225–249, and ≥ 250) with a ramp of linearly increased exposure over the 15 years prior to 1959. Lags of 5 and 10 years were considered. The analysis was limited to men whose job categories in 1959 were classified as (1) clerks, (2) signalmen, (3) engineers and firers, (4) conductors and brakemen, (5) hostlers, and (6) shop workers. These groups were subsequently combined for analysis into three groups consisting of clerks and signalmen (groups 1 and 2), train workers (groups 3 through 5), and shop workers (group 6).

METHODS USED FOR EXPOSURE-RESPONSE ANALYSES

Analyses were based on Poisson regression using the AMFIT module of the software package EPICURE (Preston et al. 1991). Previous analyses (Crump et al. 1991; OEHHA 1998; Crump 1999) also were based on Poisson regression. The variables of employment duration and job category were grouped as described above. Unless noted otherwise, analyses were stratified by attained age (five-year categories) and calendar year (single-year categories). The STRATA command of AMFIT was used to include all interactions among these variables. Duration of employment and measures of cumulative exposure were lagged for five years; alternative analyses using a ten-year lag yielded very similar results. Analyses used deaths in which the underlying cause was lung cancer; analyses that included deaths in which lung cancer was coded as a secondary cause produced similar results.

The results presented are based on the log-linear model (used by OEHHA) in which the relative risk is calculated by

$$RR = e^{\alpha GRP + \beta D},$$

where *GRP* is an indicator variable for groups defined by job category, and *D* is a measure of duration of employment or exposure. Both the estimated coefficients (α and β) and the associated relative risks are presented. Other analyses, based on the linear model (used in many of the analyses conducted by Crump and associates [1991])

$$RR = e^{\alpha GRP}[1 + \beta D],$$

led to conclusions similar to those from the log-linear model. For graphic presentation, relative risks by job category and exposure duration were calculated. Confidence intervals were based on the asymptotic standard errors of α or β. Statistical tests were based on the likelihood ratio statistic. All reported *p* values are two-tailed.

RESULTS OF EXPOSURE-RESPONSE ANALYSES

Other analysts have assigned exposure rates to job categories and multiplied these by various measures of exposure duration. For this reason, the Panel's initial analyses addressed the effects of both duration of employment and job category. For these analyses, three broad job category groups were defined as indicated in Table C.1.

Results of various models are shown in Table C.2. Model 1, which included variables for both job category (*GRP*) and employment duration (*D*0) fit substantially better than a model that included only employment duration ($p < 0.001$; model not shown). The coefficient for *D*0 (expressed per 10 years of employment duration) was negative when the *GRP* variable was not included. In Model 2, which included a separate employment duration coefficient for each of the three job categories, all three coefficients were negative, and this model did not fit significantly better ($p = 0.49$) than Model 1, which used a single employment duration coefficient. For graphic presentation, relative risks for each category defined by duration of employment (0–4, 5–9, 10–14, 15–17, and 18+ years) and job category were calculated with the 0–4-year category for clerks serving as the referent category. These relative risks are shown in Figure C.1.

The next set of analyses explored variables similar to those used by OEHHA in which one constant exposure rate was assigned to clerks and signalmen and another rate to train workers. The exposure rates given in Table 7-2 of the California OEHHA report (1998) were 39 µg/m^3 for clerks and 82 µg/m^3 for train workers. When background exposure (the value for clerks) was subtracted, the result was 0 µg/m^3 for clerks and 43 µg/m^3 for train workers. Because one of the issues of interest was the effect of subtracting background exposure, two exposure variables were defined: *D*1 with no background correction, which equaled 39 µg/m^3 for clerks and 82 µg/m^3 for train workers; and *D*2, with the background exposure subtracted, which equaled 0 µg/m^3 for clerks and 43 µg/m^3 for train workers. Shop workers were excluded from these analyses to be consistent with those of other analysts. (Again, the Panel's analyses were aimed at understanding the data and the factors that influenced risk estimates obtained by others, and not at developing a model for QRA.)

The analyses by OEHHA used exposure measures similar to the *D*2 variable described above; they used exposure intensities of 40, 50, or 80 µg/m^3 for train workers, which were intended to reflect different assumptions regarding baseline exposure concentrations (as described in section 7.2.1.4 of OEHHA 1998). Because the Panel used durations and intensities of exposure that were not identical to those used by the OEHHA, the quantitative risk estimate analyses are not directly comparable. However, the Panel believes that the direction and statistical significance of the effect for the *D*2 variable should be reasonably comparable with the OEHHA results.

Table C.1. Number of Lung Cancer Deaths and Person-Years of Follow-Up by Job Category from Railroad Worker Cohort Data

Job Category	Deaths from Lung Cancer	Person-Years of Follow-Up
Clerks and signalmen	307	220,802
Train workers (including engineers, firemen, conductors, brakemen, and hostlers)	752	462,951
Shop workers	321	190,874

Model 3 included only the *GRP* variable and Models 4 and 5 included only the quantitative cumulative exposure measure *D*1 or *D*2, respectively. Without the *GRP* variable in Models 4 and 5, the coefficients for both *D*1 and *D*2 were positive, but the *p* value for statistical significance was smaller when *D*2 (with background correction) was used (Model 5: $p = 0.005$) than when *D*1 (with no background correction) was used (Model 4: $p = 0.10$). When *GRP* was added (Models 6 and 7), the fit was improved significantly and the coefficients for both *D*1 and *D*2 became negative. In addition, the relative risks for train workers compared with clerks and signalmen became larger than in Model 3, where the variable adjusting for

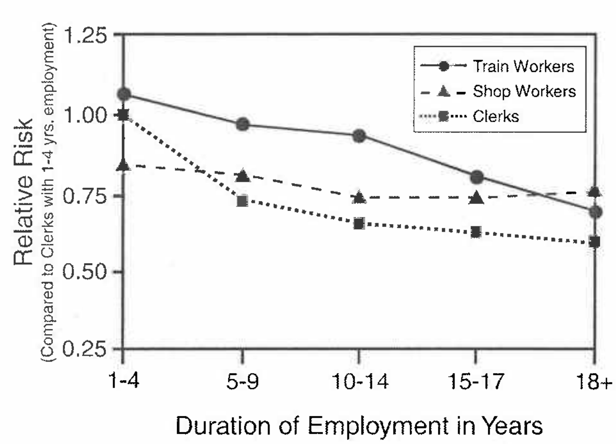

Figure C.1. Panel's analysis depicting consistently elevated risk of lung cancer for train workers compared with clerks for each time period, but decreasing risk by job category over duration of employment.

Table C.2. Estimated Coefficients and Relative Risks with 95% Confidence Intervals for Job Category Groups, Duration of Employment (*D*0), and Cumulative Exposure (*D*1 and *D*2)

Variable	Coefficient α or $\beta^{a,b}$ (95% CI)	Relative Risk (e^{α} or e^{β})[c,d] (95% CI)	Two-Sided *p* Value
Model 1			
GRP			
Clerks and signalmen	0.0	1.0	
Train workers	0.26 (0.13, 0.40)	1.3 (1.1, 1.5)	< 0.001
Shop workers	0.12 (−0.04, 0.27)	1.1 (1.0, 1.3)	0.14
*D*0 (Duration of employment)	−0.29 (−0.50, −0.09)[a]	0.7 (0.6, 0.9)[c]	0.006
Model 2			
GRP			
Clerks and signalmen	0.0	1.0	
Train workers	0.25 (−0.11, 0.60)	1.3 (0.9, 1.8)	0.18
Shop workers	−0.08 (−0.49, 0.33)	0.9 (0.6, 1.4)	> 0.5
*D*0 (Duration of exposure)			
Clerks and signalmen	−0.35 (−0.64, −0.06)[a]	0.7 (0.5, 0.9)[c]	0.02
Train workers	−0.33 (−0.57, −0.10)[a]	0.7 (0.6, 0.9)[c]	0.007
Shop workers	−0.18 (−0.46, 0.10)[a]	0.8 (0.6, 1.1)[c]	0.22
Model 3			
GRP			
Clerks and signalmen	0.0	1.0	
Train workers	0.26 (0.12, 0.39)	1.3 (1.1, 1.5)	< 0.001
Model 4			
*D*1 (No background correction)	0.17 (−0.04, 0.37)	1.2 (1.0, 1.5)	0.10
Model 5			
*D*2 (Background correction)	0.33 (0.10, 0.57)	1.4 (1.1, 1.8)	0.005
Model 6			
GRP			
Clerks and signalmen	0.0	1.0	
Train workers	0.48 (0.27, 0.69)	1.6 (1.3, 2.0)	< 0.001
*D*1 (No background correction)	−0.43 (−0.75, −0.10)[b]	0.7 (0.5, 0.9)[d]	0.011
Model 7			
GRP			
Clerks and signalmen	0.0	1.0	
Train workers	0.50 (0.19, 0.81)	1.6 (1.2, 2.2)	0.002
*D*2 (Background correction)	−0.47 (−1.01, 0.07)[b]	0.6 (0.4, 1.1)[d]	0.09

[a] Coefficient β per 10 years.

[b] Coefficient β per 10^3 ($\mu g/m^3$)-years.

[c] Relative risk e^{β} per 10 years.

[d] Relative risk e^{β} per 10^3 ($\mu g/m^3$)-years.

exposure duration was not included. Analyses based on linear models resulted in a similar pattern, where the sign of the coefficient changed from positive to negative when the *GRP* variable was added to the model.

In Table C.2, the differences in relative risk between train workers and clerks/signalmen, as measured by the parameter α, were assumed not to depend on age or calendar year period. That is, the relative risk of lung cancer for train workers compared with clerks and signalmen was assumed to be the same for all age and calendar year periods.

Further exploration of these data revealed that these relative risks were not constant; risks for train workers increased with calendar year period (after adjustment for age and duration of employment), whereas risks for clerks and signalmen showed little evidence of such an increase. Although the Panel has not explored these differences in detail, they nevertheless illustrate the complexity of these data and the difficulties of providing an adequate summary measure of effect. Calendar year and cumulative exposure are highly correlated, which makes it especially difficult to sort out their separate effects; correlation coefficients (calendar year and cumulative exposure), weighted by person-years, were 0.90 for clerks and signalmen, 0.94 for train workers, and 0.87 for shop workers.

Because of the dependencies noted above, analyses using separate calendar year and age adjustments for each of the three job category groups were also conducted by stratifying on age, calendar year, and *GRP*. Using this approach, the coefficients (with 95% CI) for duration of employment (analogous to those presented in Table C.2, Model 2) were −0.01 (−0.47, 0.44) per 10 years for clerks, −0.55 (−0.84, −0.27) per 10 years for train workers, and −0.09 (−0.46, 0.29) per 10 years for shop workers. The coefficients for *D*1 and *D*2 (analogous to analyses based on Models 6 and 7) were −0.62 (−0.95, −0.28) per 10^3 ($\mu g/m^3$)-years for *D*1, and −1.28 (−1.94, −0.62) per 10^3 ($\mu g/m^3$)-years for *D*2.

Several approaches for adjusting for age and calendar year were explored, including (1) substituting age in 1959 for age at risk, (2) not including interactions of age and calendar year, and (3) treating age as a continuous variable (log-linear) instead of as a categorical variable. Results of fitting these various methods of adjustment to Models 5 and 7 (with *D*2) are shown in Table C.3. With all methods of adjustment, the coefficients from Model 5 (with *D*2 alone) were positive and differed significantly from zero. Also in all cases, these coefficients became negative when a variable measuring differences between train workers and clerks/signalmen (*GRP*) was added (Model 7). However, in some cases (not shown), interaction terms improved the fits of various models, especially if age in 1959 was used instead of age at risk. Also, treating age at risk (or age in 1959) categorically improved the fit over treating these variables continuously.

DISCUSSION

The analyses described above demonstrate that the lung cancer risks for train workers were higher than for clerks and signalmen, and that shop workers had intermediate risks. Within the exposed groups (train workers and shop workers), lung cancer risk decreased with increasing dura-

Table C.3. Estimated Coefficients and 95% Confidence Intervals for Simple Measures of Exposure (*D*2) Based on Different Adjustments to Models 5 and 7 for Age and Calendar Year

Method of Adjusting for Age and Calendar Year[a]	Coefficient β per 10^3 ($\mu g/m^3$)-Years	
	Model 5 Without *GRP* in Model	Model 7 With *GRP* in Model
Age at risk[b], Year, Interaction	0.33 (0.10, 0.57)	−0.47 (−1.01, 0.07)
Age at risk[b], Year	0.32 (0.08, 0.55)	−0.50 (−1.03, 0.04)
Age at risk[c], Year	0.41 (0.17, 0.64)	−0.09 (−0.62, 0.45)
Age in 1959[d], Year, Interaction	0.33 (0.09, 0.56)	−0.49 (−1.04, 0.05)
Age in 1959[d], Year	0.37 (0.14, 0.61)	−0.22 (−0.76, 0.32)
Age in 1959[c], Year	0.41 (0.17, 0.64)	−0.09 (−0.62, 0.45)

[a] "Year" is treated as 18 single-year categories from 1959 through 1976. "Interaction" includes all possible interaction terms for the two variables indicated.

[b] "Age at risk" is treated as 8 five-year categories 40–44, 45–49, . . . , 75–79.

[c] Age is treated as a continuous variable.

[d] "Age in 1959" is treated as 5 five-year categories 40–44, 45–49, . . . , 60–64.

tion of employment, although this decrease was statistically significant only for the train workers. If exposure to diesel exhaust increased the risk of lung cancer in a monotonic fashion, such decreases would not be expected.

Simple measures of exposure, determined by multiplying duration of employment by exposure intensities assumed to be constant for the clerks/signalmen and train worker groups, were also analyzed. With no adjustment for job category, a positive slope was obtained, which was statistically significant when zero intensity was assumed for the clerks and signalmen group. To clarify the extent to which this positive response was due to the difference in baseline risks for train workers compared with clerks and signalmen, the variable *GRP* to measure this difference was included in the model. When this was done, the direction of association with exposure became negative; this result reflects entirely the decreasing association with increasing employment duration for train workers, and demonstrates that the positive exposure-response relation obtained with Models 4 and 5 was entirely due to the baseline differences between the two job categories.

The exposure measure defined for Model 5 above was categorized as > 0–465, 466–626, and 627 or more ($\mu g/m^3$)-years. Compared with the 0 category, the relative risks (and 95% CIs) are 1.4 (1.2, 1.7), 1.3 (1.1, 1.6), and 1.1 (0.9, 1.3), respectively. The clerks and signalmen comprised the 0 category, and the positive exposure categories were equivalent to duration of employment categories for train workers. For the train workers, the cut points 466 and 627 ($\mu g/m^3$)-years correspond to 10.8 and 14.6 years (or 130 and 175 months in the original categorization of the data).

The exposure-response function indicated by the relative risks noted in the previous paragraph and the decrease in risk with increasing duration of employment shown in Figure C.1 is not consistent with a positively increasing association between cumulative exposure to diesel exhaust and lung cancer risk. Even if the estimated exposure intensities were incorrect, a positive trend with duration of employment would be expected for the exposed groups (including train workers) if lung cancer risk increased consistently with increasing cumulative exposure. Furthermore, if the difference between train workers and clerks/signalmen were primarily due to differences in exposure, one would expect the relative risk for train workers, compared with clerks and signalmen, to be smaller or even eliminated after adjusting for exposure. However, adjusting for exposure increased this relative risk, as shown with Models 6 and 7 (compared with Model 3) in Table C.2.

The above analyses consider the ramp pattern of exposure (see Figure 7 in the chapter Summary of Railroad Worker and Teamster Studies); however, analyses using the roof pattern of exposure produced similar results. For Models 4 and 5 using the roof pattern, the slopes for cumulative exposure *D*1 and *D*2 increased to 0.64 and 0.97, respectively. When *GRP* was included, as in Models 6 and 7, the slopes for *D*1 and *D*2 became negative (–0.82 and –0.86, respectively). Thus, the coefficients for cumulative exposure using the roof pattern responded in the very same manner as they did using the ramp pattern, changing from positive to negative when the variable for job category (*GRP*) was included.

The OEHHA also applied a multistage model to the data to make quantitative risk estimates. This involved assigning exposure concentrations to job categories for modeling. As a correction for background exposure, the clerks and signalmen were given values of zero exposure rate as was done in Model 5 of Table C.2. The OEHHA reported a positive dose-response relation, as is also shown with Model 5. This multistage approach is likely to have the same difficulties with cumulative exposure as were pointed out in the discussion of Models 5 and 7.

The differences between train workers and clerks/signalmen and the negative association with employment duration within job category (especially the train workers) indicate a strong likelihood of bias due to unmeasured variables, such as smoking, or to differential follow-up among the groups being compared, or to both. The reasons for these biases are not known, but it is the Panel's opinion that their probable presence makes these data unsuitable for QRA.

In addition, the strong correlation between calendar year and duration of employment makes it very difficult to sort out the separate effects of these variables. In a study with excellent data on exposure and on other risk factors for lung cancer, this might be possible. However, this study did not include data that clearly distinguish exposure rates among workers, and did not indicate changes in these rates over time for individual workers. Data on potential confounders such as smoking were also unavailable. Although the railroad worker data do not show an increasing relation between exposure to diesel exhaust and risk of lung cancer, the possibility that strong biases in these data have masked a true association cannot be ruled out. It is also possible that the follow-up period has been too short for effects to become evident, or that the true exposure-response relation in these data is nonmonotonic. With these limited data, it is not possible to determine whether the exposure-response relation is, in fact, nonmonotonic, or the result of bias in the data.

Model 5 is similar to the model used as the basis for the California OEHHA's risk assessment (1998). This model does not fit the data, as was demonstrated by the strong improvement in fit when the variable reflecting the difference between train workers and clerks/signalmen (*GRP*) was added (Model 7). Analyses using Model 5 differ from OEHHA's analyses in that (1) the employment duration measure OEHHA used did not take into account the portion of the year (months) workers were employed, and (2) the methods used to adjust for age and calendar year period were slightly different. Although these differences could affect the quantitative estimates, it seems unlikely that they would affect qualitative conclusions.

Crump (Crump et al. 1991; Crump 1999) also has conducted many analyses of the railroad worker data, and has investigated duration of employment as well as more complex measures of exposure than the Panel used in its analyses. However, Crump's results are likely to reflect the negative association of duration of employment within job categories. Crump has noted that the OEHHA positive slope is driven by the difference between train workers and clerks/signalmen (Crump 1999), and the Panel's analyses confirm this. The Panel used results of the analyses with and without terms for job category, in an attempt to clarify the roles of job category (as a measure of exposure intensity) and employment duration, and to understand to a greater extent than in previous discussions of these analyses the differences in results obtained by OEHHA and by Crump and colleagues.

Methods to adjust for age and calendar year, particularly regarding the choice between attained age or birth cohort (equivalent to age in 1959), have received considerable discussion. Because any two of the variables (attained age, birth cohort, and calendar year) determine the third, this choice in itself should not matter provided that an interaction among the variables is allowed. However, different results might arise because of the number and definition of the categories used, or because interactions were not included in the model. The California OEHHA (1998) has conducted analyses, applying many different treatments of age and calendar year, with little evidence of an important impact on results. The Panel's investigation of this issue confirms this conclusion, in that analyses were not greatly affected by the method of adjusting for age and calendar year.

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The Panel greatly appreciates the helpful cooperation of Drs. Eric Garshick, Kenny Crump, and Stanley Dawson in providing data and other information regarding their analyses of the railroad worker data.

Appendix D. Potential Impact of Control Selection Bias

The Panel, having raised the possibility that bias could have been introduced during the selection of control groups for the case-control studies by Garshick and colleagues (1987) and Steenland and coworkers (1990), offers hypothetical examples showing the potential for bias in case-control studies with deaths from "other causes." "Other causes" in these examples are depicted as CVD mortality because it is the leading cause of death among men; the problems arise because CVD often is associated strongly with smoking as well as with choice of occupation. The Panel presents five different scenarios concerning the association between (1) diesel exhaust and lung cancer, (2) diesel exhaust and "other" causes of death, (3) smoking and lung cancer, (4) smoking and the "other" causes of death, and (5) diesel exhaust, smoking, and lung cancer. These examples demonstrate that case-control studies using "other" causes of death as the control group have the potential to produce misleading results.

In all the examples it is assumed that:

- smoking has a strong, positive effect on lung cancer mortality risk: RR = 7.00; and
- smoking has a weaker, positive effect on CVD mortality risk: RR = 2.00.

The examples differ by:

- whether exposure to diesel exhaust has a positive effect (RR > 1.00) or no effect (RR = 1.00) on lung cancer risk;
- whether smoking is correlated with diesel exhaust exposure, with 65%, 50%, or 35% of smokers in the exposed group; and
- whether CVD risk is increased (RR = 1.54) or decreased (RR = 0.65) among exposed persons, within strata of cigarette smoking.

In each example, a cohort study that lacked information on smoking would provide a biased estimate of the crude relative risk (in the row in each section of the tables labeled "Total"). A case-control study with CVD deaths as controls and with information on smoking, as conducted by Garshick and colleagues (1987) and Steenland and coworkers (1990), would provide estimates of the crude and stratum-specific relative risks in the last column of each table.

Table D.1 includes data for the first three examples. In all three, exposure to diesel exhaust *has no effect on* lung cancer, and exposed persons are *at lower risk* of CVD than unexposed persons within strata of smoking. Smoking is associated with diesel exhaust in a different direction for each example.

In the first example (section A of Table D.1), smoking is positively associated with diesel exposure. A cohort study of this population would report a crude RR = 1.58, which would be due entirely to confounding by smoking. A case-control study with CVD deaths for controls would report a crude estimate of RR = 1.99, which would appear to be due only partially to confounding by smoking. The smoking-adjusted estimate from the case-control study would be RR = 1.54, very similar to the unadjusted estimate of 1.58 from the cohort study. The adjustment for smoking in the case-control study would be falsely reassuring because of control selection bias.

In the second example (section B of Table D.1), smoking is inversely associated with exposure. If the case-control study only were performed, as in the case of the study by Steenland and colleagues, the implausible RR = 0.63 in the cohort, unadjusted for smoking, would never be seen. The case-control study would find a weak association between exposure and lung cancer (RR = 1.19) before adjusting for smoking, which would become stronger (RR = 1.54) when smoking is controlled. However, the scenario assumes that diesel exposure conditional on smoking status has no effect on lung cancer (RR = 1.00).

In the third example (section C of Table D.1), smoking is unassociated with exposure. As in the second example, suppose that only the case-control study is conducted. Control selection bias resulting from the use of CVD controls would produce an upwardly biased estimate of RR = 1.54, whether or not smoking is controlled for in the analysis.

Table D.2 includes data for the fourth and fifth examples. For both hypotheses, exposure to diesel exhaust *increases* lung cancer risk, and exposed persons are *at higher risk* of CVD than unexposed persons within the strata of smoking. The association of smoking and diesel

Table D.1. Hypothetical Examples in Which Exposure to Diesel Exhaust Has No Effect on Lung Cancer Risk, Exposed Persons Are at Lower Risk of Cardiovascular Disease Than Unexposed Persons Within Strata of Smoking, and the Association Between Smoking and Exposure Changes

			Risk		Cases		Relative Risk of Lung Cancer[a]	
Smoking	Diesel Exposure	Number of Persons	Lung Cancer	Cardio-vascular Disease	Lung Cancer	Cardio-vascular Disease	Cohort	Case Control
A. Smoking Is Positively Associated With Exposure								
Yes	Yes	65,000	0.00280	0.01300	182	845	1.00	**1.54**
	No	35,000	0.00280	0.02000	98	700	1.	1.
No	Yes	35,000	0.00040	0.00650	14	228	1.00	**1.54**
	No	65,000	0.00040	0.01000	26	650	1.	1.
Total	Yes	100,000	0.00196		196	1,073	**1.58**	**1.99**
	No	100,000	0.00124		124	1,350	1.	1.
B. Smoking Is Inversely Associated with Exposure								
Yes	Yes	35,000	0.00280	0.01300	98	455	1.00	**1.54**
	No	65,000	0.00280	0.02000	182	1,300	1.	1.
No	Yes	65,000	0.00040	0.00650	26	423	1.00	**1.54**
	No	35,000	0.00040	0.01000	14	350	1.	1.
Total	Yes	100,000	0.00124		124	878	**0.63**	**1.19**
	No	100,000	0.00196		196	1,650	1.	1.
C. Smoking is Unassociated with Exposure								
Yes	Yes	50,000	0.00280	0.01300	140	650	1.00	**1.54**
	No	50,000	0.00280	0.02000	140	1,000	1.	1.
No	Yes	50,000	0.00040	0.00650	20	325	1.00	**1.54**
	No	50,000	0.00040	0.01000	20	500	1.	1.
Total	Yes	100,000	0.0016		160	975	**1.00**	**1.54**
	No	100,000	0.0016		160	1,500	1.	1.

[a] Results from a cohort study without smoking information and from a case-control study with CVD controls and smoking information are shown in bold.

exhaust is assumed to go in opposite directions for each example.

In the fourth example (section A of Table D.2), smoking is positively associated with exposure. The cohort study with no smoking information gives too high an estimate (RR = 3.16) of the actual effect of exposure to diesel exhaust on lung cancer risk (RR = 2.00). Because of control selection bias, the estimates from the case-control study are too low, regardless of whether they are computed with (RR = 1.30) or without (RR = 1.68) adjustment for smoking.

In the fifth example (section B of Table D.2), smoking is inversely associated with exposure. As in the fourth example, the unadjusted result of the cohort study and the unadjusted and adjusted results of the case-control study underestimate the effect of exposure on lung cancer risk.

These examples show that a severely distorted estimate of the association between exposure to diesel exhaust and lung cancer, and a severely distorted picture of the direction and degree of confounding by cigarette smoking, can come from case-control studies in which the controls are a collection of "other deaths" composed largely of CVD deaths.

Table D.2. Hypothetical Examples in Which Exposure to Diesel Exhaust Increases Lung Cancer Risk, Exposed Persons Are at Higher Risk of Cardiovascular Disease Than Unexposed Persons Within Strata of Smoking, and the Association Between Smoking and Exposure Changes

			Risk		Cases		Relative Risk of Lung Cancer[a]	
Smoking	Diesel Exposure	Number of Persons	Lung Cancer	Cardio-vascular Disease	Lung Cancer	Cardio-vascular Disease	Cohort	Case Control
A. Smoking Is Positively Associated with Exposure								
Yes	Yes	65,000	0.00280	0.02000	182	1,300	2.00	**1.30**
	No	35,000	0.00140	0.01300	49	455	1.	1.
No	Yes	35,000	0.00040	0.01000	14	350	2.00	**1.30**
	No	65,000	0.00020	0.00650	13	423	1.	1.
Total	Yes	100,000	0.00196		196	1,650	**3.16**	**1.68**
	No	100,000	0.00062		62	878	1.	1.
B. Smoking is Inversely Associated with Exposure								
Yes	Yes	35,000	0.00280	0.02000	98	700	2.00	**1.30**
	No	65,000	0.00140	0.01300	91	845	1.	1.
No	Yes	65,000	0.00040	0.01000	26	650	2.00	**1.30**
	No	35,000	0.00020	0.00650	7	228	1.	1.
Total	Yes	100,000	0.00124		124	1,350	**1.27**	**1.01**
	No	100,000	0.00098		98	1,073	1.	1.

[a] Results from a cohort study without smoking information and from a case-control study with CVD controls and smoking information are shown in bold.

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Abbreviations

AEM	adjusted extracted mass
ARP	adjusted respirable particles
CI	confidence interval
CVD	cardiovascular disease
DPM	diesel particulate matter
EC_1	elemental carbon with an aerodynamic diameter of 1 µm or less
EPA	Environmental Protection Agency (California or U.S.)
ETS	environmental tobacco smoke
IARC	International Agency for Research on Cancer
ICD 8	International Classification of Disease, Version 8
ILSI	International Life Sciences Institute
NCI	National Cancer Institute
NFRAQS	Northern Front Range Air Quality Study
NIOSH	National Institute of Occupational Safety and Health
NO_x	oxides of nitrogen
NTP	National Toxicology Program
OEHHA	Office of Environmental Health Hazard Assessment
QRA	quantitative risk assessment
RR	relative risk
RRB	Railroad Retirement Board
RSP	respirable-sized particles
TEX	total extractable material
VMT	vehicle miles traveled
WHO	World Health Organization

Related HEI Publications: Diesel Engine Exhaust

Research Reports

Report No.	Title	Principal Investigator	Publication Date
Constituents of Diesel Exhaust: Metabolism, Biomarkers, and Carcinogenicity			
2	Disposition and Metabolism of Free and Particle-Associated Nitropyrenes After Inhalation	J. Bond	1986
4	The Metabolic Activation and DNA Adducts of Dinitropyrenes	F. Beland	1986
7	DNA Adducts of Nitropyrene Detected by Specific Antibodies	J.D. Groopman	1987
16	Metabolism and Biological Effects of Nitropyrene and Related Compounds	C.M. King	1988
17	Studies on the Metabolism and Biological Effects of Nitropyrene and Related Nitro-Polycyclic Aromatic Compounds in Diploid Human Fibroblasts	V.M. Maher	1988
19	Factors Affecting Possible Carcinogenicity of Inhaled Nitropyrene Aerosols	R.K. Wolff	1988
26	Investigation of a Potential Cotumorigenic Effect of the Dioxides of Nitrogen and Sulfur, and of Diesel-Engine Exhaust on the Respiratory Tract of Syrian Golden Hamsters	U. Heinrich	1989
31	DNA Binding by 1-Nitropyrene and Dinitropyrenes in Vitro and in Vivo: Effects of Nitroreductase Induction	F.A. Beland	1989
32	Respiratory Carcinogenesis of Nitroaromatics	R.C. Moon	1990
33	Markers of Exposure to Diesel Exhaust in Railroad Workers	M.B. Schenker	1990
34	Metabolic Activation of Nitropyrene and Diesel Particulate Extracts	A.M Jeffrey	1990
46	Role of Ring Oxidation in the Metabolic Activation of 1-Nitropyrene	F.A. Beland	1991
55	Mutations Induced by 1-Nitrosopyrene and Related Compounds During DNA Replication in Human Cells and Induction of Homologous Recombination by These Compounds	V.M. Maher	1993
61	Methods Development Toward the Measurement of Polyaromatic Hydrocarbon–DNA Adducts by Mass Spectrometry	R. Giese	1993
64	Biomonitoring of Nitropolynuclear Aromatic Hydrocarbons via Protein and DNA Adducts	K. El-Bayoumy	1994
66	The Effects of Copollutants on the Metabolism and DNA Binding of Carcinogens	P. Howard	1994
68	Pulmonary Toxicity of Inhaled Diesel Exhaust and Carbon Black in Chronically Exposed Rats		
	Part I: Neoplastic and Nonneoplastic Lung Lesions	J.L. Mauderly	1994
	Part II: DNA Damage	K. Randerath	1995

(Continued on next page)

Research Reports

Report No.	Title	Principal Investigator	Publication Date
72	DNA Adduct Formation and T-Lymphocyte Mutation Induction in F344 Rats Treated With 1,6-Dinitropyrene	F.A. Beland	1995
84	Evaluation of the Potential Health Effects of the Atmospheric Reaction Products of Polycyclic Aromatic Hydrocarbons	J. Arey	1999
Dosimetry			
10	Predictive Models for Deposition of Inhaled Diesel Exhaust Particles in Humans and Laboratory Species	C.P. Yu	1987
40	Retention Modeling of Diesel Exhaust Particles in Rats and Humans	C.P. Yu	1991
Emissions			
5	An Investigation into the Effect of a Ceramic Particle Trap on the Chemical Mutagens in Diesel Exhaust	S.T. Bagley	1987
56	Characterization of Particle- and Vapor-Phase Organic Fraction Emissions from a Heavy-Duty Diesel Engine Equipped with a Particle Trap and Regeneration Controls	S.T. Bagley	1993

Special Reports

	Diesel Exhaust: A Critical Analysis of Emissions, Exposure, and Health Effects (In press)	1995

HEI Communications

7	Diesel Workshop: Building a Research Strategy to Improve Risk Assessment	1999

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Carcinogenicity of diesel-engine and gasoline-engine exhausts and some nitroarenes

In June, 2012, 24 experts from seven countries met at the International Agency for Research on Cancer (IARC; Lyon, France) to assess the carcinogenicity of diesel and gasoline engine exhausts, and some nitroarenes. These assessments will be published as Volume 105 of the IARC Monographs.[1]

Diesel engines are used for on-road and non-road transport (eg, trains, ships) and (heavy) equipment in various industrial sectors (eg, mining, construction), and in electricity generators, particularly in developing countries. Gasoline engines are used for cars and hand-held equipment (eg, chainsaws).

Emissions from these engines are complex, with varying composition. The gas phase consists of carbon monoxide, nitrogen oxides, and volatile organic compounds such as benzene and formaldehyde. Particles consist of elemental and organic carbon, ash, sulfate, and metals. Polycyclic aromatic hydrocarbons and nitroarenes are distributed over the gas and the particle phase. The qualitative and quantitative composition of exhausts depends on the fuel, the type and age of the engine, the state of its tuning and maintenance, the emission control system, and pattern of use. Diesel-engine exhaust from engines with no or limited emission controls contains more particulate matter.[2]

In the past two decades, progressively tighter emission standards for on-road vehicles, introduced in North America, Europe, and elsewhere, have triggered advances in diesel technology that resulted in lower emission of particulate matter, nitrogen oxides, and hydrocarbons. Emission standards in non-road applications are lagging and therefore are still largely uncontrolled today. Moreover, in many less developed countries standards are not in place for both on-road and non-road use of diesel and gasoline engines.

The most influential epidemiological studies assessing cancer risks associated with diesel-engine exhausts investigated occupational exposure among non-metal miners, railroad workers, and workers in the trucking industry. The US miners study included a cohort analysis[3] and a nested case–control analysis that was adjusted for tobacco smoking.[4] Both showed positive trends in lung cancer risk with increasing exposure to diesel exhaust, as quantified via estimated elemental carbon as a proxy of exposure. Trends were significant in the nested case–control study, with a 2–3-fold increased risk in the highest categories of cumulative or average exposure. This study provides some of the strongest evidence of an association between exposure to diesel-engine exhaust and lung cancer since there were few potential confounding exposures in these underground mines, and high diesel exposures were well documented in current surveys.

In another US study,[5] a 40% increased risk for lung cancer was observed in railroad workers exposed to diesel exhaust compared with individuals exposed to low levels of or no emissions. Indirect adjustment for smoking suggested that differences in smoking could not have influenced this excess risk substantially. This study was later extended by estimating diesel exposure on the basis of work history and history of dieselisation of different railroads, and showed a significantly increased risk for exposed workers of 70–80%; risk increased with duration of exposure but not with cumulative exposure.[6]

A large cohort study in the US trucking industry[7] reported a 15–40% increased lung cancer risk in drivers and dockworkers with regular exposure to diesel exhaust. There was a significant trend of increasing risks with longer duration of employment, with 20 years of employment roughly doubling the risk after adjusting for tobacco smoking. When this study was extended with an exposure assessment involving contemporary measurements and exposure reconstruction on the basis of elemental carbon, positive trends were observed for cumulative but not average exposure. These trends were more pronounced when adjustment for duration of work was included.[8]

The findings of these cohort studies were supported by those in other occupational groups and by case–control studies including various occupations involving exposure to diesel-engine exhaust. A positive exposure–response relationship was found in several studies from Europe and the USA, many of which were adjusted for tobacco smoking. Most notably, a pooled analysis of 11 population-based case–control studies from Europe and Canada showed a smoking-adjusted increased risk for lung cancer after exposure to diesel engine exhaust, which was assessed by a job exposure matrix, and a positive dose response in terms of both a cumulative exposure index and duration of exposure.[9]

These epidemiological studies support a causal association between exposure to diesel-engine exhaust and lung cancer. An increased risk for bladder cancer was also noted in many but not all available case–control studies. However, such risks were not observed in cohort studies. The Working Group concluded that there was “sufficient evidence” in humans for the carcinogenicity of diesel-engine exhaust.

The diesel-engine exhausts and their extracts used in carcinogenicity studies with experimental animals were generated from fuels and diesel engines produced before 2000. The studies were considered by type of

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Conflicts of interest

DBK has received research funding from Caterpillar and from British Petroleum. MvT has received research funding from Statoil, CONCAWE, and CEFIC. JG has received research funding from CONCAWE. DG is the President of the Health Effects Institute (the Institute's funding comes in equal part from the US Environmental Protection Agency and the makers of motor vehicles for sale in the USA). TH is an employee of Navistar (manufacturer of diesel trucks and engines). TLL served as a consultant to the diesel industry through Cambridge Environmental. RM serves as a consultant for the Engine Manufacturers Association, Navistar International, Cummins Engine Company, Shell Exploration and Production Company, Union Pacific, and the American Petroleum Institute. PM is a member of the Scientific Advisory Group of European Research Group on Environment and Health in the Transport Sector. DP holds stock in Daimler-Benz AG and was employed until 2008 by BASF. JCW is Vice President and Chief Technical Officer of Cummins, and holds stock and patents. SM holds stock in BHP Billiton Limited. All other Working Group members, specialists, representatives, and secretariat declare that they have no conflicts of interest.

See Online for appendix

	Evidence of carcinogenicity in experimental animals	Mechanistic evidence	Overall evaluation
3,7-Dinitrofluoranthene	Sufficient	Weak	2B
3,9-Dinitrofluoranthene	Sufficient	Weak	2B
1,3-Dinitropyrene	Sufficient	Weak	2B
1,6-Dinitropyrene	Sufficient	Moderate	2B
1,8-Dinitropyrene	Sufficient	Moderate	2B
3-Nitrobenzanthrone	Limited	Strong	2B*
6-Nitrochrysene	Sufficient	Strong	2A*
2-Nitrofluorene	Sufficient	Weak	2B
1-Nitropyrene	Sufficient	Strong	2A*
4-Nitropyrene	Sufficient	Moderate	2B

*Strong mechanistic evidence contributed to the overall evaluation.

***Table:* Evaluation of some nitroarenes**

exposure: whole diesel-engine exhaust; gas-phase diesel-engine exhaust (with particles removed); and extracts of diesel-engine exhaust particles. Whole diesel-engine exhaust caused an increased incidence of lung tumours in rats.[10] Diesel-engine exhaust particles instilled intratracheally caused benign and malignant lung tumours in rats,[11] and the particle extracts also caused lung carcinomas in rats and sarcomas at the injection site in mice.[12,13] Gas-phase diesel-engine exhaust did not increase incidence of respiratory tumours in any species tested. The Working Group concluded that there was "sufficient evidence" in experimental animals for the carcinogenicity of whole diesel-engine exhaust, of diesel-engine exhaust particles and of extracts of diesel-engine exhaust particles.

Diesel-engine exhaust, diesel-exhaust particles, diesel-exhaust condensates, and organic solvent extracts of diesel-engine exhaust particles induced, in vitro and in vivo, various forms of DNA damage, including bulky adducts, oxidative damage, strand breaks, unscheduled synthesis, mutations, sister chromatid exchange, morphological cell transformation in mammalian cells, and mutations in bacteria.[14] Increased expression of genes involved in xeno-biotic metabolism, oxidative stress, inflammation, antioxidant response, apoptosis, and cell cycle in mammalian cells was observed.

Positive genotoxicity biomarkers of exposure and effect were also observed in humans exposed to diesel engine exhaust. The Working Group concluded that there is "strong evidence" for the ability of whole diesel-engine exhaust to induce cancer in humans through genotoxicity.

Gasoline exhaust and cancer risk was investigated in only a few epidemiological studies and, because of the difficulty to separate effect of diesel and gasoline exhaust, evidence for carcinogenicity was evaluated as "inadequate".

The Working Group considered the animal carcinogenicity studies of gasoline-engine exhaust by type of exposure: whole gasoline-engine exhaust; and extracts of gasoline-engine exhaust condensate. Organic extracts of gasoline engine-exhaust condensate induced a significant increase in lung carcinomas and papillomas of the skin in mice.[15] In rats, the gasoline-exhaust condensate induced a significant increase in lung carcinomas.[16] The Working Group concluded that there was "sufficient evidence" in experimental animals for the carcinogenicity of condensates of gasoline-engine exhaust.

Gasoline-engine exhaust induced chromosomal damage in mice, and changes in gene expression in rat lung that involved pathways related to xenobiotic metabolism and inflammation. In mammalian cells, gasoline-engine exhaust particles and organic extracts thereof induce DNA adducts, DNA strand breaks, oxidative DNA damage, chromosomal aberrations, and morphological cell transformation, as well as gene mutations in bacteria. In mammalian cells, extracts of gasoline-exhaust engine particles altered expression of genes involved in inflammation, xenobiotic metabolism, tumour progression, and cell cycle. The gaseous phase of gasoline-engine exhaust was mutagenic to bacteria. The Working Group concluded that there is "strong evidence" for a genotoxic mechanism for the carcinogenicity of organic solvent extracts of particles from gasoline engine exhaust.

In conclusion, the Working Group classified diesel engine exhaust as "carcinogenic to humans" (Group 1) and gasoline engine exhaust as "possibly carcinogenic to humans" (Group 2B).

Evaluations for ten nitroarenes, all of which have been detected in diesel-engine exhaust, are shown in the table. Biomonitoring studies have shown that workers and the general population are exposed to these substances.[17–19] All the nitro-arenes were genotoxic to various extents in different assays. The Working Group reaffirmed the Group 2B classification of seven. Strong evidence for genotoxicity led to an upgrade of 3-nitrobenzanthrone to Group 2B, and similar findings in human cells led to an upgrade of 1-nitropyrene and 6-nitrochrysene to Group 2A.

Lamia Benbrahim-Tallaa, Robert A Baan, Yann Grosse, Béatrice Lauby-Secretan, Fatiha El Ghissassi, Véronique Bouvard, Neela Guha, Dana Loomis, Kurt Straif, on behalf of the International Agency for Research on Cancer Monograph Working Group
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We declare that we have no conflicts of interest.

For references see appendix.

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Supplementary appendix

This appendix formed part of the original submission.

Supplement to: Benbrahim-Tallaa L, Baan RA, Grosse Y, et al, on behalf of the International Agency for Research on Cancer Monograph Working Group. Carcinogenicity of diesel-engine and gasoline-engine exhausts and some nitroarenes. *Lancet Oncol* 2012; published online June 15. DOI:10.1016/S1470-2045(12)70280-2.

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Impact of roadside noise barriers on particle size distributions and pollutants concentrations near freeways

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A B S T R A C T

Increasing epidemiological evidence has established an association between a host of adverse health effects and exposure to ambient particulate matter (PM) and co-pollutants, especially those emitted from motor vehicles. Although PM and their co-pollutants dispersion profiles near the open freeway have been extensively characterized by means of both experimental measurements and numerical simulations in recent years, such investigations near freeways with roadside barriers have not been well documented in the literature. A few previous studies suggested that the presence of roadside structures, such as noise barriers and vegetation, may impact the decay of pollutant concentrations downwind of the freeway by limiting the initial dispersion of traffic emissions and increasing their vertical mixing due to the upward deflection of airflow. Since the noise barriers are now common roadside features of the freeways, particularly those running through populated urban areas, it is pertinent to investigate the impact of their presence on the particles and co-pollutants concentrations in areas adjacent to busy roadways. This study investigated two highly trafficked freeways (I-710 and I-5) in Southern California, with two sampling sites for each freeway, one with and the other without the roadside noise barriers. Particle size distributions and co-pollutants concentrations were measured in the immediate proximity of freeways and at different distances downwind of the freeways. The results showed the formation of a "concentration deficit" zone in the immediate vicinity of the freeway with the presence of roadside noise barrier, followed by a surge of pollutant concentrations further downwind at 80–100 m away from freeway. The particle and co-pollutants concentrations reach background levels at farther distances of 250–400 m compared to 150–200 m at the sites without roadside noise barriers.

1. Introduction

In recent years, several toxicological studies have reported the ability of particulate matter (PM) to generate reactive oxygen species in biological systems (Sagai et al., 2000; Donaldson et al., 2002; Xia et al., 2004) and these pro-oxidant species are intimately linked to the genesis of pulmonary (Li et al., 2009) and cardiovascular (Delfino et al., 2005) injury, and even neurodegenerative disorders (Campbell, 2004; Peters et al., 2006). In urban areas, the primary source of ambient PM and their co-pollutants come from motor vehicles and traffic-induced emissions (Ning and Sioutas, 2010), which raises serious health concerns for the part of the population who live and/or work in the communities nearby busy roadways or spend several hours daily commuting. Several epidemiological studies have reported a strong and positive association between a community's proximity to highly trafficked roadways and the risk of adverse health effects among the population in the community, including asthma and other respiratory diseases (Delfino, 2002; McConnell et al., 2006), birth and developmental defects (Ritz and Yu, 1999; Wilhelm and Ritz, 2003), cardiovascular diseases (Peters et al., 2004; Delfino et al., 2005) and childhood cancer such as leukemia (Harrison et al., 1999; Pearson et al., 2000).

Particle and gaseous pollutants dispersion profiles near open freeways have been well documented by means of both experimental measurements and numerical simulations in recent years. One of the first such attempts was undertaken by Zhu et al. (2002a, b) in the vicinity of Interstate 405 and 710 freeways in Southern California. It was observed that the particle number and CO concentrations decreased exponentially, and particle size distributions shifted towards larger particle diameters as the aerosols were transported away from freeway, which the authors attributed

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to particle coagulation and turbulent dispersion. Similar experimental investigations were also carried out in other cities around the world (Gramotnev and Ristovski, 2004; Zhu et al., 2009). On the other hand, several modeling studies have attempted to explain the particles evolution near roadways (Jacobson and Seinfeld, 2004; Zhang et al., 2004; Jacobson et al., 2005). Zhang et al. (2004) used a multi-component aerosol dynamic model to fit the measurement data from Zhu et al. (2002a) studies and demonstrated that condensation/evaporation and dilution were the major mechanisms in altering aerosol size distribution downwind the freeway. A recent study by Jacobson et al. (2005) suggested that evaporation causes smaller semi-volatile particles to shrink in size and thus enhanced their coagulation rate, which played an important role in the near-source evolution of particle size distribution.

Although these experimental and modeling studies have characterized the roadside particle and co-pollutants dispersion profiles quite extensively, the roadways under investigation were often open -field without considering any roadside obstacles. These roadside structures, such as noise barrier, vegetation and buildings, may affect the characterization of pollutants decay profiles downwind of roadway by limiting or blocking the initial dispersion of traffic-induced emissions from roadway and increasing their vertical mixing due to the upward deflection of airflow caused by the obstacles (Holscher et al., 1993; Heist et al., 2009). Given that the noise barriers, built to reduce noise levels in areas nearby roadways, are common roadside features of highly trafficked freeways, particularly those running through densely populated areas, it is pertinent to investigate the effect of their roadside presence on particles and co-pollutants concentration levels in areas adjacent to the busy roadways.

Few recent studies demonstrated that a recirculation cavity, consisting of well-mixed and substantially lower concentrations of pollutants, exists in the lee of the roadside barrier (Holscher et al., 1993; Bowker et al., 2007; Baldauf et al., 2008b). This "concentration deficit zone" can extend from 3 to more than 20 times the barrier heights depending on the meteorological conditions and barrier configurations (Baldauf et al., 2008b; Heist et al., 2009). Modeling studies also suggested the existence of a "hot" zone at further distances downwind of the recirculation wake region, where the pollutant concentrations are higher than at an equivalent distance in an open area without barrier, due to the vertical elevation of roadway emissions source by the barrier and the subsequent reattachment of airflow further downwind (Bowker et al., 2007). Based on the previous investigations, the present study employed an intensive sampling campaign and examined the impact of the roadside noise barrier on the dispersion profiles of particles and co-pollutants from freeway emissions. In this study, we selected two major freeways in Southern California (I-710 and I-5) with different traffic fleet compositions. For each freeway, we have selected two sampling sites featured with- and without roadside noise barrier, respectively. The particle size distribution and co-pollutants concentrations were measured at different distances downwind of the freeways to investigate the effect of noise barrier on the decay of their concentrations and the evolution of particle size distributions from traffic-induced emissions. The results of the current study, based on real-world experimental measurement, provide direct evidence that the existence of roadside noise barrier dramatically alters the dynamics of particle and co-pollutants dispersion and the spatial distribution of pollutants concentrations in the areas nearby the freeways.

2. Experimental methodology

2.1. Site locations

An intensive summer sampling campaign has been carried out in the present study during June–July, 2009 to investigate the impact of roadside noise barrier on the dispersion profile of particles and co-pollutants emitted from freeways. Two highly trafficked freeways in greater Los Angeles area (I-710 and I-5) were selected, with two sampling sites (one with roadside noise barrier and the other without) located along the span of each freeway. At each of the four sites, a stationary sampling station was set up located in the immediate proximity of the freeways to characterize the freeway emissions, while a mobile platform was deployed along the trajectories downwind of the traffic emissions from freeway to collect ambient data at varying distances. Fig. 1 (a, b, c and d) shows the location of the four sampling sites and the route of the mobile platform at the downwind area of the selected freeways.

The I-710 non-noise barrier site (Fig. 1a) is located in the stretch of the freeway in Downey, CA. Any major roadway in the upwind direction of the stationary sampling station was at distance greater than 1 km. The inlet of the sampling instruments was extended to as close as 2 m from the freeway edge. The location of the station and the route of the mobile platform are also highlighted in Fig. 1a. I-710 noise barrier site (Fig. 1c) was located 2 km north of the non-noise barrier site in a residential neighborhood in Bell Gardens, CA, with no major roadways, other than the freeway, upwind to about 1 km from the stationary sampling station. The station was set up on the freeway curbside and the inlet reached over the noise barrier into the freeway with a short distance of 2 m from the freeway edge. The barrier was 3.7 m in height as measured above the adjacent surface road next to the noise barrier and extended more than few hundred meters from the site in both north and south bound sections along the freeway. The mobile platform route downwind of the freeway is identified in the Fig. 1c.

The I-5 non-noise barrier site (Fig. 1b) was located in the stretch of the freeway near La Mirada, CA. There were no other major roadways upwind of the sampling site other than the freeway and the vicinity of the sampling site is mainly comprised of office buildings without immediate industrial sources nearby. The stationary sampling location was set next to the freeway curb with the inlet reaching within 0.5 m to the edge. The noise barrier site in I-5 (Fig. 1d) was located in a residential neighborhood, with the roadside noise barrier extending for hundreds meters along the freeway north of the sampling location. The height of the noise barrier at the site was 5.2 m as measured above the adjacent surface road next to the noise barrier. The inlet of the stationary sampling station was extended over the barrier and reached into the freeway zone with offset about 4 m from the edge of the freeway.

2.2. Instrumentation

Two sampling instrument sets were deployed simultaneously, one at the stationary sampling station and the other in the mobile platform. A list of the instruments at both sampling stations with their data resolution is shown in Table 1. The stationary station set up included a Scanning Mobility Particle Sizer (Model 3080, TSI) configured to measure the particle size distribution in the size range of 10–225 nm. Particle-bound black carbon (BC) and co-pollutants of carbon monoxide (CO) and nitrogen dioxide (NO_2) concentrations in the immediate proximity of freeway were also measured at the station. A camera was set up on top of the sampling station to capture the traffic on the freeway and an ultrasonic anemometer was set up at a height of 4 m above the freeway road surface at all of the four sampling sites to collect meteorological data. For the noise barrier sites, the probe was placed upwind of the barrier to avoid possible interferences of the barrier on the measurements.

The mobile platform is a 1998 electric Toyota RAV4 SUV equipped with various on board monitoring instruments. The same vehicle has been used in many previous studies (Westerdahl et al., 2005; Fruin et al., 2008; Kozawa et al., 2008) in Southern California.

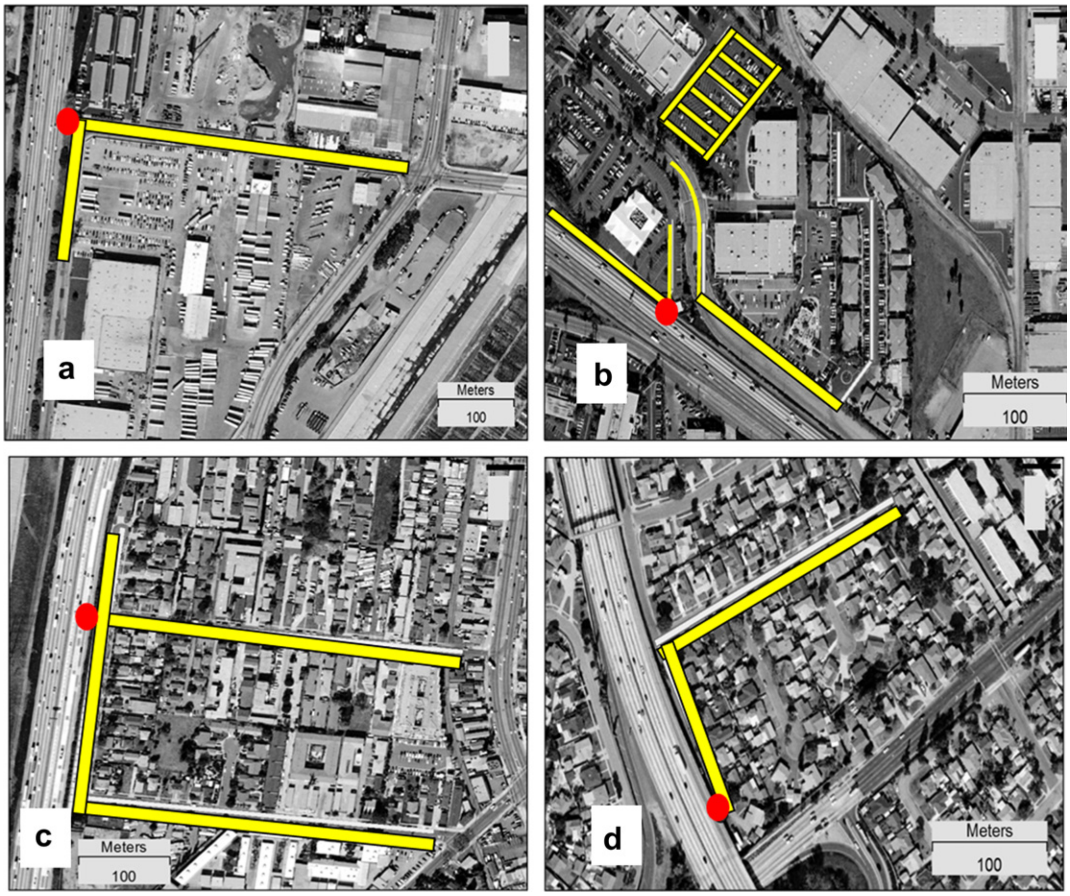

Fig. 1. Location of the sampling sites: (a) I-710 without roadside barrier; (b) I-5 without roadside barrier; (c) I-710 with roadside barrier; (d) I-5 with roadside barrier. Note: Red dot represents the stationary sampling station; the yellow lines represent the route of the mobile platform downwind of the freeway.

The sampling inlet consists of a 6-inch diameter galvanized steel duct, located 1.5 m above the roadway in the rear passenger space of the vehicle. The particle size distributions data (6–523 nm) were collected using aFast Mobility Particle Sizer(Model 3091, TSI). Particle-bound black carbon and co-pollutants (CO, NO_2) concentrations were measured simultaneously to calculate their downwind concentration ratios. A GPS unit was used to record the geocoded data of the mobile platform to derive its downwind distance from the freeway. The mobile platform was also equipped with an on board camera to distinguish a time when the measurements were impacted by a passing vehicle near the mobile platform.

Quality assurance measures, including flow and zero checks of all instruments, and regular calibration of gaseous pollutant monitoring instruments, were carried out before and after the sampling campaign. The side-by-side test results showed that two sets of continuous monitoring instruments for CO, NO_2 and BC deployed in the stationary site and in the mobile platform reported values within 5% of each other. All the instruments ran on synchronized time at both stationary station and the mobile platform. The two instrument sets were run side-by-side overnight at the beginning and end of each sampling period for the four sampling sites to assess the systematic uncertainty due to the difference of monitoring instruments and to inspect the time lag (a consequence of different flow rates, inlet lengths, and instrument response time) between the actual sampling and the reported time.

2.3. Data processing

All data from the stationary sampling station were downloaded and exported using proprietary software and data from the mobile platform were exported to a custom database for all instruments. Data used for data analysis (specified in Table 2) were chosen from the sampling time periods with the measured wind direction $\pm 45°$ from that perpendicular to the freeway, placing the sampling

Table 1
Monitoring instruments deployed in stationary sampling station and the mobile platform.

Measurement	Stationary sampling station	Mobile platform
Geodata	GPS (Garmin GPSmap 76CSx)	GPS(Garmin GPSmap 76CSx)
Particle size distribution	SMPS: TSI model 3080 (long DMA) w/TSI model 3022A (CPC) @ 5 min intervals (10–225 nm range)	FMPS: TSI model 3091 @ 20 s intervals (6–523 nm range)
Particle-bound Black Carbon	Aethalometer: Anderson model 14 (dual channel) @ 1 min intervals	Aethalometer: Magee Scientific @ 1 min intervals
CO	QTrak – TSI model 7565 @ 1 min intervals	Teledyne-API model 300E for CO @ 20 s intervals
NO2	Teledyne-API model 200A @ 1 min intervals	Teledyne-API Model 200E @ 20 s intervals
Meteorological data	3-D ultrasonic anemometer (RS Young model 81 000) @ 1 min intervals	2-D Ultrasonic anemometer (RS Young) @ 1 s intervals

Table 2
Summary of the meteorological parameters and average pollutant concentrations measured in the immediate proximity of the freeways from stationary sampling station.

Sampling sites		I-710		I-5	
		Non-noise barrier	Noise barrier	Non-noise barrier	Noise barrier
Samping dates and time		06/08/09 (2PM–5PM); 06/09/09 (3PM–7PM)	06/02/09 (1PM–4PM); 06/05/09 (1PM–5PM)	07/06/09 (1PM–4PM); 07/02/09 (12PM–4PM)	06/25/09 (1PM–5PM); 06/29/09 (1PM–5PM)
Total Vehicle Flow[a] (vehicles $hour^{-1}$)	Average	12 170	12 212	8460	8677
	Stdev	563	599	405	300
Truck Flow[a] (vehicles $hour^{-1}$)	Average	490	516	673	610
	Stdev	124	101	136	138
T (°C)	Average	21.7	23.7	28.4	25.0
	Stdev	0.9	2.3	1.0	4.5
RH (%)	Average	57.0	43.3	48.6	51.0
	Stdev	4.4	2.5	8.8	3.5
Wind speed (m s^{-1})	Average	2.0	3.1	1.9	0.9
	Stdev	0.3	0.5	0.4	0.2
Wind Direction[b] (deg true N)	Average	233	229	225	225
	Stdev	16	10	42	25
CO (ppm)	Average	1.5	1.4		
	Stdev	0.4	0.1		
BC (μg m^{-3})	Average	11.0	11.6	10.6	9.5
	Stdev	6.3	1.4	4.2	1.5
NO_2 (ppb)	Average	152.2	87.3	93.9	79.3
	Stdev	38.0	8.2	31.2	4.9
SMPS Number Concontration (# cm^{-3})	Average	1.2e5	1.1e5	8.0e4	7.5e4
	Stdev	5.0e4	2.3e4	3.4e4	2.4e4
SMPS Mass Concentration (μg m^{-3}) (10–225 nm)	Average	6.4	6.7	7.5	7.2
	Stdev	2.4	1.5	3.1	1.7

[a] The traffic volume and composition data were obtained from California Freeway Performance Measurement System (PeMS) by CalTrans.
[b] Wind directions perpendicular to roadway are 270 and 225° true N for I-710 and I-5 sites, respectively.

locations of the mobile platform in the direct downwind vicinity of the selected roadway region. The time periods that were influenced by non-freeway emissions (i.e. a truck passing by the mobile platform) were excluded from the data analysis. GPS tracking data were exported and converted to determine the mobile platform's perpendicular downwind distance to the freeway. The particle size distribution and other pollutants concentration data at various downwind distances were segregated into several distance ranges, and the distance values presented in the *X*-axis of the figures hereafter represent the midpoint of each distance range. Additional information is listed in detail in the Supporting information file. The concentration ratios of NO_2, CO, and BC at different downwind distances of the freeway were determined by normalizing the downwind data from mobile platform with their corresponding data collected from the stationary sampling station. For CO, the data for the I-5 freeway at the stationary station were not available due to a malfunctioning instrument, therefore absolute concentrations are presented. The particle size distribution data were further segregated into several size groups to derive their respective number and mass concentrations at various distances. The particle mass concentrations were determined by their corresponding particle volume concentrations and particle density of 1.2 g cm^{-3} (Geller et al., 2006).

3. Results and discussion

3.1. Overview of the sampling campaign

Table 2 shows the summary of the meteorological conditions, traffic volumes and average freeway pollutants concentrations measured in the immediate proximity of the freeways during the sampling campaign. Similar temperature and humidity conditions were observed among different sites. The average wind directions were in the range of 225 and 233° to the north, placing the selected sampling sites directly downwind of the freeways, and the mean wind speed was in the range of 0.9–3.1 m s^{-1}. Traffic data were obtained from the California Department of Transportation 'California Freeway Performance Measurement System' (PeMS) corresponding to the sampling periods, and the vehicles on both north and south bound directions have been counted. The total traffic flows measured on I-710 and I-5 were ~12 200 and ~8500 vehicles $hour^{-1}$, respectively, with a lower truck flow, e.g. heavy duty diesel vehicles, on I-710 (~500 trucks $hour^{-1}$) than I-5 (~640 trucks $hour^{-1}$). For the two sites at the same freeway, the traffic volume and truck composition were very consistent. The similarity of their meteorological and traffic conditions allows for a direct comparison between the results of the barrier and non-barrier sites.

The average CO concentrations were 1.5 ± 0.4 and 1.4 ± 0.1 ppm at the two sites in the immediate proximity of I-170 freeway. Their concentrations near I-5 were not reported in Table 2 due to a malfunctioning of the instrument. The BC concentrations measured in the two sites at I-710 freeway were 11.0 ± 6.3 and 11.6 ± 1.4 μg m^{-3}, comparable to 10.6 ± 4.2 and 9.5 ± 1.5 μg m^{-3} measured at I-5. In comparison to the previous measurement on I-710 freeway (Westerdahl et al., 2005), in which the BC and CO concentrations were 12 μg m^{-3} and 1.9 ppm as measured while driving on the same freeways using a mobile platform, the results from both studies were very consistent. The average particle number concentrations measured by SMPS (10–225 nm) at both I-710 sites (1.2 ± 0.5e5 and 1.1 ± 0.2e5 particles cm^{-3}) are higher than those at I-5 sites (8.0 ± 3.4e4 and 7.5 ± 2.4e4 particles cm^{-3}), due to the higher traffic volume on I-710.

3.2. Evolution of particle size distributions downwind of freeway

Fig. 2a and b show the average particle size distributions at various distances downwind of I-710 (20, 40, 80, 200 and 450 m) and I-5 (20, 40, 90, 120, 400 m) freeways without roadside noise barriers as measured by FMPS (6–523 nm). The size distributions

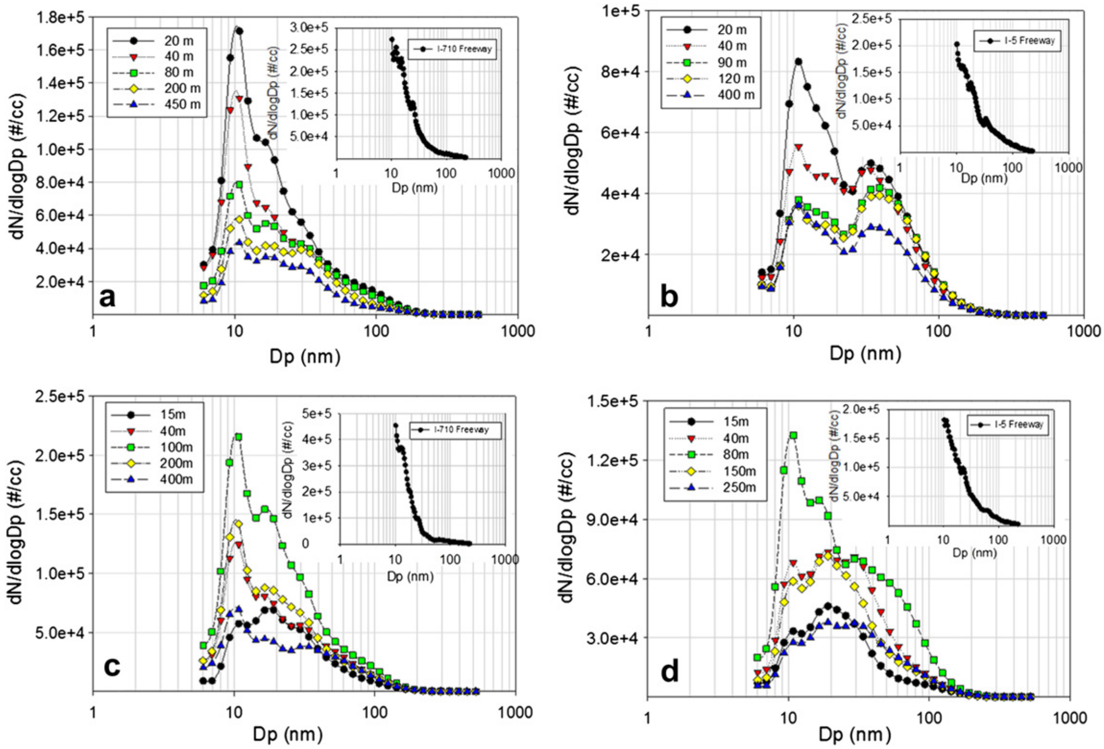

Fig. 2. Particle size distributions measured at various distances downwind of freeway using FMPS (6–523 nm) and in the immediate proximity of freeway using SMPS (10–225 nm) shown as subplot: (a) I-710 without roadside barrier; (b) I-5 without roadside barrier; (c) I-710 with roadside barrier; (d) I-5 with roadside barrier.

measured in the immediate proximity of the freeways using the SMPS (10–225 nm) are also included as subplots in the figures for comparison. For all plots, the horizontal axis represents particle size on a log scale while the vertical axis represents normalized particle number concentration. Data points represent averages from multiple scans taken at a given sampling location.

As shown in Fig. 2a and b (subplots), the particle size distributions in the immediate proximity of both freeways displayed a unimodal shape, with a distinct peak at approximately 10 nm (~10 nm), indicating new particle formation by nucleation of supersaturated semi-volatile organic vapors in the exhaust (Alam et al., 2003). Shortly after highly concentrated vapors (i.e. semi-volatile organic compounds) are emitted from the tailpipe of vehicles on freeway, the rapid cooling in the atmosphere causes them to nucleate and form large numbers of nucleation mode particles (Zhang and Wexler, 2004). The peak modal concentrations at ~10 nm are 2.7e5 and 2.0e5 particles cm^{-3} for I-710 and I-5 freeways, respectively.

As particles were transported away from the freeway, the particle size distributions changed markedly, with a dramatic decrease in the number concentrations. In Fig. 2a, the particle number concentrations at ~10 nm were 1.7e5, 1.3e5 and 7.9e4 particles cm^{-3}, at 20 m, 40 m, and 80 m, respectively, which accounted for only 63%, 48%, and 29% of that measured in the immediate proximity of freeway. Similar observations were also reported by Zhu et al. (2002b) near another freeway (I-405) in Southern California. Several atmospheric processes may contribute to this significant change in size distribution and concentration, including particle evaporation and diffusion (Hinds, 1999) and semi-volatile vapor condensation (Zhang et al., 2004). Due to their small size, particles of 10 nm have much higher diffusion coefficients than larger particles, and the dynamics of their evaporation are more pronounced due to the "Kelvin effect" (Hinds, 1999). The evaporated organic vapors, in addition to those from fresh vehicle emissions, may also condense onto pre-existing particles and form larger size particles. Although it was hypothesized the collision of small particles by coagulation may contribute to the deceasing particle number concentration (Zhu et al., 2002b), previous experimental measurement (Shi et al., 1999) and theoretical studies (Vignati et al., 1999; Zhang et al., 2004) have indicated that the role of coagulation is rather negligible in affecting the overall decay in particle concentration. At 200 m, the particle size distribution displays a broad shoulder between 20 and 50 nm, similar to that measured at 450 m, a clear indication that the particle concentrations have reached background levels at 200 m where the size distributions no longer change significantly with distance.

On the other hand, Fig. 2b shows the particle size distributions at various distances downwind of the I-5 freeway. In contrast to the observations near I-710, the particle size distributions displayed a consistent bimodal trend. The first mode appeared at ~10 nm, similar to the measurement near I-710 freeway, while there existed a distinct second mode in the larger size range of 30–50 nm. At 20 m, the modal concentration at ~10 nm was 8.3e4 particles cm^{-3}, nearly half of that measured in the immediate proximity of the freeway, indicating rapid dilution and the associated particle evaporation and diffusional loss. Compared with the corresponding downwind distance of I-710 freeway, the ~10 nm modal concentration is significantly lower at the I-5 site, whereas the second peak, observed at around 35 nm, has similar concentrations at sites near both freeways, resulting in a pronounced dip at ~25 nm in the bimodal distributions at the I-5 sites. The lower nucleation mode particle concentrations indicate a lower strength of fresh traffic emissions at the I-5 freeway, with much lower traffic flow than the I-710 (~8500 vehicles $hour^{-1}$ on I-5 versus ~12 200 vehicles $hour^{-1}$ on I-710). As the particles are further transported away from the freeway, particle number concentrations gradually decrease at both modes, and the second mode is shifted from 34 nm (at 20 m) to about 40 nm (at 120 m), indicating the possibility of small particle evaporation and vapor condensation onto pre-existing particles

(Shi et al., 1999; Zhang et al., 2004) as well as possible coagulation at different dilution conditions (Hinds, 1999; Zhu et al., 2002b). At 120 m, the nucleation mode particles at ~10 nm reached a concentration of 3.6e4 particles cm^{-3}, similar to the background level at 450 m; however, number concentration of particles at the larger size mode of 39 nm continued to drop after 120 m until it reached background levels at 400 m. Nucleation mode particles have a shorter residence time in the atmosphere, so they decay much faster and reach background levels at a shorter distance than larger particles (Raes et al., 2000).

Fig. 2c and d show the average particle size distributions at various distances downwind of the sections of I-710 (15, 40, 100, 200, 400 m) and I-5 (15, 40, 80, 150, 250 m) freeways with roadside noise barriers. Compared with the non-barrier sites, the particle size distributions and number concentrations were consistent at the same freeway when the traffic volume and fleet composition were relatively consistent during the days of sampling. As shown in both figures, with increasing downwind distance from the freeways, the evolution of particle size distributions displayed a dramatically different pattern with those at the non-barrier sites: the size distribution at distances close to the freeway (15 m) in the barrier sites showed significantly lower number concentrations for both freeways, while the peak size distribution and particle concentrations appeared at further downwind distances of 80–100 m, followed by a gradual decrease in concentrations until they reached background levels at beyond 250 m.

As shown in Fig. 2c, at 15 m downwind of I-710 freeway, particle size distributions displayed a uni-modal trend, with a slight peak at 10 nm and a broad shoulder at 16–19 nm. The 10 nm modal concentration is 5.7e4 particles cm^{-3}, i.e. significantly lower than that (1.7e5 particles cm^{-3}) measured at a similar downwind distance (20 m) without roadside noise barriers, as shown in Fig. 2a. A similar trend was also observed at 15 m downwind of I-5 with a roadside barrier (shown in Fig. 2d) where the peak modal number concentration at 10 nm was 3.1e4 particles cm^{-3}, 64% lower than that (8.5e4 particles cm^{-3}) measured at 20 m from non-noise barrier site. Modeling results have shown that the presence of a roadside noise barrier alters the dispersion patterns of traffic emissions and the trajectory of particles traveling downwind from their source (Bowker et al., 2007). The freeway vehicular emissions travel upward from the road level due to the presence of the roadside barrier, effectively inducing an "elevated" source. In the lee of the roadway noise barrier, vertical mixing occurs due to strong turbulence (Finn et al., 2010) creating a well-mixed downwind side zone with relatively lower pollutant concentrations. Depending on the road configuration and meteorological conditions, the recirculation cavity may extend from 3 to 20 times the noise barrier height (Baldauf et al., 2008b; Heist et al., 2009). The particle number concentration deficits observed in the downwind vicinity of the noise barrier strongly support the existence of a recirculation cavity as reported in literature (Bowker et al., 2007; Baldauf et al., 2008b; Finn et al., 2010).

With increasing downwind distance from freeways, particle number concentrations gradually increased and the nucleation mode at ~10 nm became more pronounced, indicating the diminishing of the recirculation cavity and the increasing influence of freeway emissions. At 40 m, the modal concentration at ~10 nm was 1.2e5 and 6.8e4 particles cm^{-3} for I-710 and I-5 freeway, respectively, about two times higher than those measured at 10–15 m. As the particles are further transported away from the recirculation cavity, the elevated source follows its trajectory and the plume gradually reattaches to the ground (Bowker et al., 2007). The peak size distribution and number concentration were observed at 100 m and 80 m for the I-710 and I-5 freeway, respectively. For the I-710, the modal concentration of 10 nm at 100 m is 2.2e5 particles cm^{-3}, 55% of that measured in the immediate proximity of freeway (4.0e5 particles cm^{-3}). The uni-modal particle size distribution at 100 m also resembles that observed at 20 m near non-barrier I-710 freeway (Fig. 2a). It displays a similar level of nucleation mode peak concentrations, thus indicating similar dilution -induced particle evaporation and a more pronounced shoulder at 19 nm, which may be attributed to re-condensation of the evaporated semi-volatile species, as argued by Zhang et al. (2004). This is also confirmed by similar observations at the I-5 freeway, where the particle size distribution at 80 m with roadside barriers (Fig. 2d) has a broader second mode at ~30 nm (7.0e4 particles cm^{-3}), in contrast to the corresponding peak at 20 m (5.0e4 particles cm^{-3}) near non-barrier I-5 (Fig. 2b). In comparison to similar downwind distance between the sites, the total number concentration at 100 m downwind of freeway with roadside barrier was 1.9 and 2.2 times of that at 80–90 m for non-barrier I-710 and I-5 freeway, respectively. Previous investigations have shown that particle number concentrations reach the background levels at a distance of 100–200 m downwind of freeway, depending on wind speed and meteorological conditions (Zhu et al., 2002b). The observations made in this study indicate that the presence of roadside noise barriers dramatically changes particles dispersion profiles and affects their concentrations distribution downwind of the freeway. At 200 m downwind of I-710 with roadside barriers, particle size distribution still displays a sharp uni-modal shape, with peak concentrations of 1.4e5 particles cm^{-3} at 10 nm, which is 2.5 times the background level measured at 200 m for the I-710 site without roadside barrier. A similar observation can also be made for the I-5 freeway at 150 m downwind of the barrier, where the ~10 nm modal concentration is 1.6 times that measured at corresponding distance of 120 m for the non-barrier I-5 sites.

As the particles traveled further downwind at 400 m near I-710, the particle size distribution and number concentration reached the background level as shown in Fig. 2c. The much longer downwind distance (400 m versus 200 m) needed to reach background levels indicates a larger impact zone from traffic emission sources for freeway sections featured with roadside noise barriers. For I-5 freeway with roadside barrier, the background level of particle size distribution and concentrations was reached at 250 m, as shown in Fig. 2d. The difference of the needed distances to reach background levels between the two freeways may be explained by the higher initial particle number concentration at the I-710, thus the longer time necessary for it to decrease to background concentrations.

3.3. Particle number and concentrations at different downwind distances

Fig. 3 shows the particle number (primary *Y* axis) and mass concentrations (secondary *Y* axis) with increasing downwind distances of the freeways without (Fig. 3a and b) and with (Fig. 3c and d) roadside noise barriers. The data points at $x = 0$ m represent the average number/mass concentrations in the immediate proximity of the freeways derived from SMPS (10–225 nm) while data points beyond $x = 0$ m represent average number/mass concentration downwind of the freeways as derived from FMPS measurement (6–523 nm). The corresponding error bars denote one standard deviation of measured particle number or mass concentration. Due to the different size ranges of the measurements, the data points derived from FMPS and SMPS were plotted separately in the figures for clarity.

As shown in Fig. 3a and b, total particle number concentrations measured in the immediate proximity of I-710 (1.2e5 particles cm^{-3}) were higher than I-5 freeway (8.0e4 particles cm^{-3}) due to the higher total traffic volume on the I-710. As the downwind distance increased, the number concentrations decayed exponentially due to the evaporation of semi-volatile particles and the diffusion of

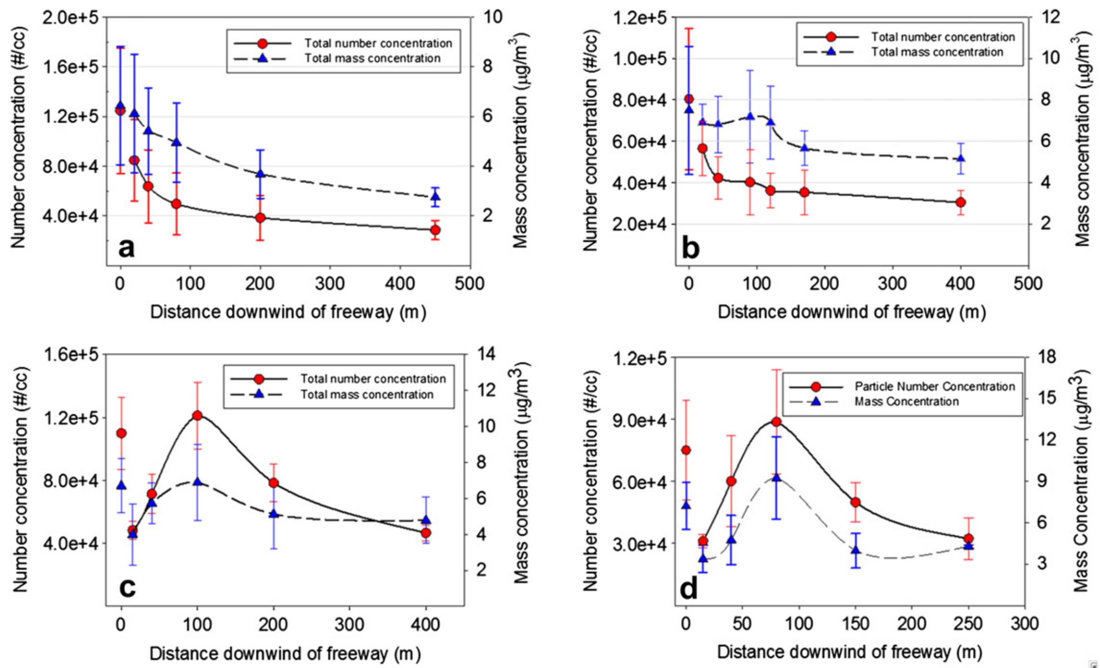

Fig. 3. Particle number and mass concentrations at different distance downwind of the freeway (a) I-710 no noise barrier (b) I-5 no noise barrier; (c) I-710 with noise barrier; (d) I-5 with noise barrier. Note: The total particle number and mass concentrations at $X = 0$ are derived from SMPS (10–225 nm) data at stationary sampling station; the concentrations at $X > 0$ are derived from FMPS (6–523 nm) data.

nucleation mode particles, as discussed in detail in the previous section. The concentrations reached background levels within 200 m and 120 m for I-710 and I-5, respectively, where the measured number concentration was only 45% and 64% of that measured at 20 m near its corresponding freeway. For both sites, the observed background particle number concentrations were similar at 3.0e4 particles cm^{-3}, which is a very typical urban background level across the Los Angeles Basin during that time period (Westerdahl et al., 2005; Moore et al., 2009). The faster decay trend for I-710 freeway may be attributed to the higher initial particle number concentration observed inside the I-710. Similar to the overall decay trend of number concentration, the total mass concentration (for the range of 6–523 nm) also decreased with increasing downwind distance in both freeways. However, the decay of mass concentration is much slower than number concentrations, as shown in Fig. 3a and b. The rapid dilution next to the freeway not only lowers particle concentration by dispersion, but also causes evaporation of semi-volatile species off the particle surface, which is more pronounced with decreasing particle size, due to the Kelvin effect (Hinds, 1999). The overall result is an accelerated decrease in number concentrations of smaller than larger particles. The evaporated vapors from the smaller range of ultrafine PM, combined with those from fresh vehicle emissions, may further condense onto pre-existing particles, resulting in a slower decay of particle mass concentration. At 200 m, the particle mass concentrations were 3.7 and 5.6 μg m^{-3} for I-710 and I-5, respectively, and are comparable to those measured at 400 m, suggesting that PM mass concentration also reached background levels within 200 m.

Fig. 3c and d show the particle number and mass concentrations in the immediate proximity and downwind of I-710 and I-5 with roadside noise barriers. Compared with those at non-barrier freeway sites, the particle concentration distribution displayed a significantly different trend, exemplifying the impact of a roadside barrier on the particle dispersion profiles. At 15 m, particle number concentrations were 4.8e4 and 3.1e4 particle cm^{-3} at I-710 and I-5 sites, respectively, 43% and 45% lower than those measured at 20 m downwind of corresponding freeway without roadside barrier. A similar trend was also observed for particle mass concentrations at the same sites. The particle concentration deficit observed at 15 m strongly underscores the existence of the recirculation cavity in the lee of the roadway barrier (Bowker et al., 2007; Baldauf et al., 2008b). As the downwind distance increased, the particle concentrations increased and reached a maximum at 100 m and 80 m for I-710 and I-5, respectively. The peak particle number concentrations are 2.4 and 2.2 times higher than those observed at corresponding distance for non-barrier sites at the I-710 and I-5 freeways. As the aerosols traveled further downwind, the particle number concentrations gradually decreased and reached background levels at 400 m; while the particle mass concentrations became stabilized to background levels earlier, at 200 m. The differential trend of particle mass and number concentrations highlights the role of semi-volatile species evaporation and re-condensation in the dynamics of particles evolution in the atmosphere (Vignati et al., 1999; Zhang et al., 2004; Ning and Sioutas, 2010). It is noted that a similar trend is also observed next to the freeways without roadside barriers (Fig. 3a and b), where particle mass concentration decayed much slower than number concentrations during the rapid dilution.

3.4. Size-segregated particle number concentrations at different downwind distances

Fig. 4 shows the average size-segregated particle number concentrations at different distances downwind of the freeways. The particle size distributions measured by FMPS (6–523 nm) were segregated into five different mobility size ranges of 6–25, 25–50, 50–100, 100–300 and 300–550 nm, respectively. The measured number concentrations in the size bins within each size range were added to derive the concentration of each size group.

As shown in Fig. 4a and b, particles in different size ranges behaved quite differently as the distance from freeways increased. The number concentration of particles in the size range of 6–25 nm

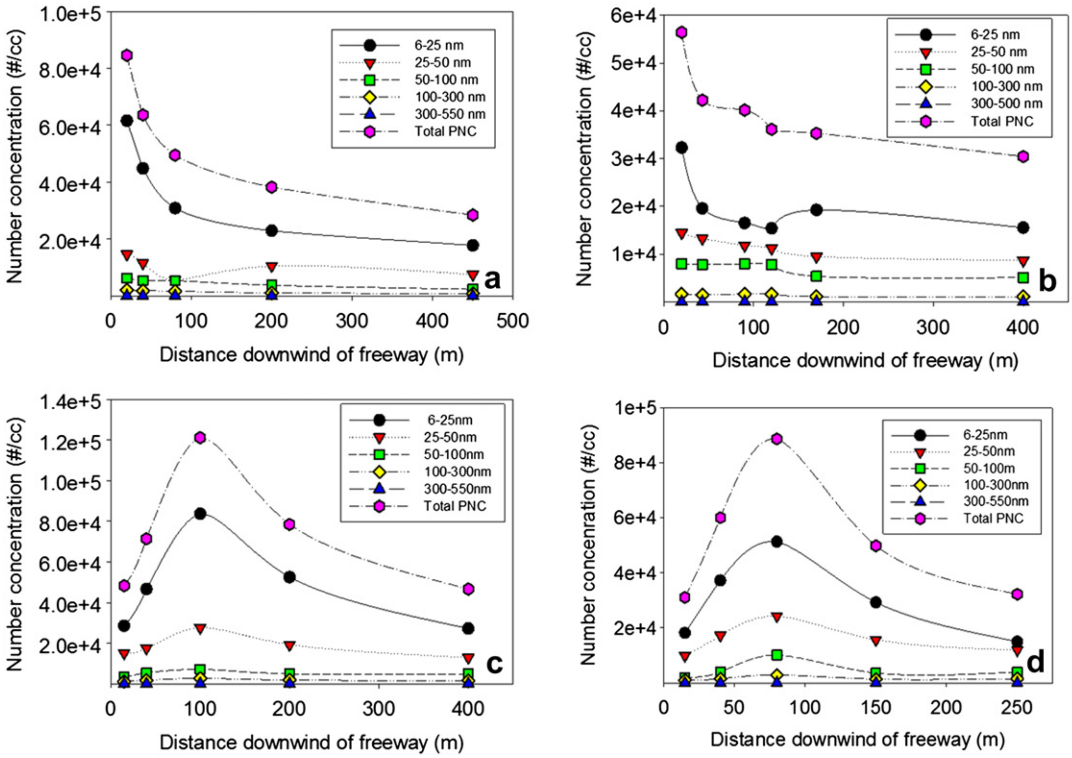

Fig. 4. Size-segregated particle number concentrations at different distances downwind of the freeway (a) I-710 no noise barrier (b) I-5 no noise barrier; (c) I-710 with noise barrier; (d) I-5 with noise barrier. Note: Total PNC is the total particle number concentration derived from FMPS.

accounted for 73% and 57% of the total number concentration at 15 m next to I-710 and I-5 freeways, respectively. The large fraction of <25 nm particles is consistent with the observation of Ntziachristos et al. (2007) and Zhu et al. (2002b) conducted next to the same freeway. As the particles are advected away from freeway, the 6–25 nm particles number concentrations decreased by half from 15 m to 80–90 m for I-710 and I-5, respectively, and gradually leveled off beyond 200 m. This observation is also reflected in the rapid drop of the nucleation peak displayed in the particle size distribution plots (Fig. 2a and b) from nearby the freeway to 100 m downwind. With increasing particle size, number concentrations decayed more slowly, illustrating the effect of size-dependent particle evaporation due to the Kelvin effect, and diffusion during rapid dilution. On the other hand, particles above 100 nm did not experience a substantial change in their number concentration with increasing downwind distance to the freeway, suggesting the insignificant contribution of freeway emissions to their concentrations in the atmosphere. Fig. 4c and d show size-segregated particle number concentrations for the barrier sites for I-710 and I-5 at various downwind distances. Close to the freeways at 15 m, the particle number concentrations in all size ranges were significantly lower than those at similar distances in non-barrier conditions and even comparable to those measured at background, a clear indication that the presence of roadside barrier induces a recirculation cavity in the lee of the barrier with deficit of pollutants concentrations. An evident peak of particle number concentrations in the ranges of 6–25 nm, 25–50 nm and 50–100 nm is observed at 100 m and 80 m for I-710 and I-5, where the reattachment of pollutants plume from traffic emissions occurs. Compared to the non-barrier freeway conditions, the number concentrations of particles in different size ranges near barrier freeway reached background levels at a farther distance of 400 m and 250 m for I-710 and I-5 freeways.

3.5. Co-pollutants concentrations at different downwind distances

Fig. 5 shows the concentrations ratios of carbon monoxide (CO), nitrogen dioxide (NO2) and black carbon (BC) at various distances downwind of the freeways with no roadside noise barrier (3a: I-710; 3b: I-5) and with barrier (3c: I-710; 3d: I-5). The concentration ratios were calculated by dividing the average concentrations measured at different downwind distances by the average concentrations in the immediate proximity of the freeways ($x = 0$). Error bars represent one standard deviation of the average ratios. CO concentrations for I-5 were expressed as absolute downwind concentrations in the secondary *Y* axis due to a malfunction of the CO monitor used at the site in the immediate proximity of I-5. These species were selected because their concentrations in urban environments are closely related to traffic emissions. For the concentration ratios in Fig. 5a and b, exponential decay curves were used to fit the decreasing ratios with increasing downwind distances. The best fitting decay equations and their corresponding R^2 values are listed in Table 3.

As shown in Fig. 5a and b, all pollutants concentration ratios decreased exponentially with increasing downwind distances of the freeway. For the gaseous species of CO and NO_2, their concentrations decreased by 70–80% within the first 100 m for both freeways. Particle-bound BC concentration dropped by 60% and 80% in the first 100 m for I-710 and I-5, respectively. Within 150 m, all pollutants concentrations reach asymptotically background levels. Similar observations have been reported extensively in the recent literature (Zhu et al., 2002b; Baldauf et al., 2008a; Clements et al., 2009). As shown in Table 2, the decay coefficients of NO_2 and BC for I-710 were consistently higher than that for I-5, suggesting a faster decay of their concentrations near the I-710 freeway. This may be explained by their higher initial concentrations of these pollutants at the I-710 freeway, which has a roughly 50% higher

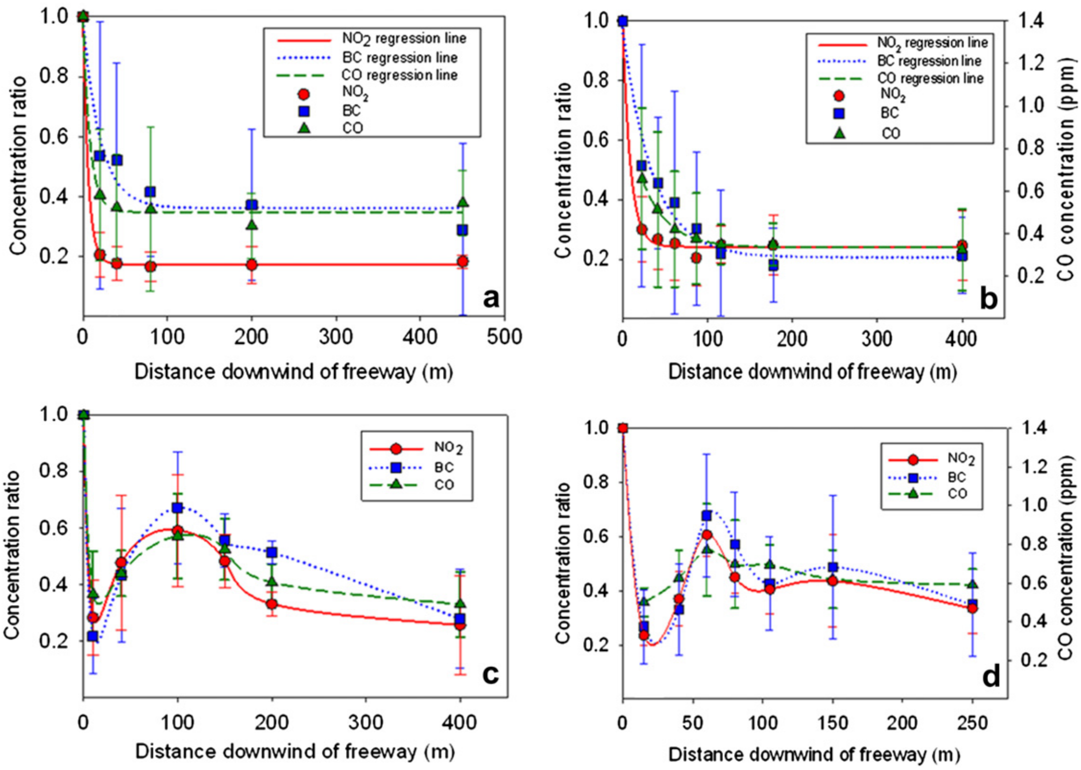

Fig. 5. BC and gaseous pollutants normalized concentrations at different distance downwind of the freeway (a) I-710 no noise barrier (b) I-5 no noise barrier; (c) I-710 with noise barrier; (d) I-5 with noise barrier.

traffic volume than the I-5 freeway. Other meteorological conditions and the local topography may also contribute to the decay curves of air pollutants from the freeway (Zhu et al., 2004), but given the overall similarity in both of these sets of parameters between the two freeways, we attribute the faster decrease in the I-710 to the higher traffic volume in that freeway.

In contrast, the concentration ratios downwind of the freeway sections with roadside noise barriers displayed a different trend, as shown in Fig. 5c and d. At downwind distance of 15 m, the closest location downwind of the I-710, the pollutants concentration ratios were 0.36, 0.28 and 0.22 for CO, NO_2 and BC, respectively, comparable to the background levels measured at 400 m (0.33, 0.26, and 0.28 for CO, NO_2 and BC, respectively). The low concentration ratios are consistent with the observations of particle number and mass concentrations, due to the strong turbulence that exists in the recirculation cavity of the roadside noise barrier (Finn et al., 2010). At 80–100 m, where the concentrations have dropped to background levels for the non-barrier sites (Fig. 5a), the pollutants displayed a peak ratio of 0.57, 0.59, and 0.67 for CO, NO_2, and BC, respectively, as shown in Fig. 5c for the I-710 with barrier. The dramatic difference of the pollutant concentration profiles downwind of the freeway underscores the impact of roadside noise barrier on pollutant dispersion. As the pollutants are transported further away from freeways, their concentrations gradually decrease and reach background concentrations at 400 m and 250 m for I-710 and I-5, respectively. The results suggest that the freeway roadside features, such as noise barriers, should also be taken into consideration in assessing public exposure to ambient pollutants from traffic emissions in the community nearby busy freeways.

Table 3
Concentration decay curve equation and coefficients ("*x*" is the distance downwind of the freeway from the stationary sampling station; "*y*" is the normalized concentration ratio).

	NO_2	BC	CO
I-710	$y = 0.17 + 0.83$ $e^{(-0.16x)} R^2 = 0.99$	$y = 0.36 + 0.63$ $e^{(-0.05x)}\ R^2 = 0.97$	$y = 0.35 + 0.65$ $e^{(-0.12x)}\ R^2 = 0.99$
I-5	$y = 0.24 + 0.76$ $e^{(-0.11x);}\ R^2 = 0.99$	$y = 0.21 + 0.77$ $e^{(-0.03x)}\ R^2 = 0.98$	–

4. Summary and conclusions

The present study investigated the evolution of particle size distributions and pollutants concentrations downwind of two major freeways (I-710 and I-5) sections in Southern California, both featured with and without roadside noise barriers. The results corroborate those of earlier studies by showing that the particle number and pollutants concentrations decay exponentially near freeways without the roadside noise barriers. Particle number concentrations decrease sharply with distance from the freeway, especially for smaller (<30 nm) particles due to evaporation and diffusion. The background pollutant concentrations are reached within 150 m downwind of freeway without roadside barriers.

With the presence of roadside barrier, the dynamics of particle and co-pollutants dispersion change dramatically. A recirculation cavity is formed in the close vicinity downwind of the barrier, as observed at 15 m in the present study, resulting in a concentration deficit zone in the lee of the barrier, where the particle number concentrations are 45–50% of those measured at similar downwind distances of freeways without roadside barrier. The particle size distributions and co-pollutants concentrations were comparable to background levels. With the increasing downwind distance, particles and gaseous co-pollutant concentrations increase and peak at 80–100 m, where the plume of elevated traffic emissions sources reattaches to the ground. The particle size distribution displayed a sharp nucleation mode peak, with total number concentrations

1.9–2.2 times of those at similar distance near non-barrier freeways. Particle mass, CO, NO_2 and BC also reached maximum concentrations ratios. The background particle and co-pollutants concentrations were reached at distances of 250–450 m, farther than the sites near non-barrier freeways.

The much longer downwind distance needed to reach background levels indicates a larger impact zone of traffic emission sources near the freeways with roadside noise barriers. Our results suggest that freeway roadside features, such as noise barriers and plantation, should also be taken into consideration in assessing population exposure to ambient particles and co-pollutants from traffic emissions.

Acknowledgements

We would like to acknowledge Dr. Katharine Moore for her significant contributions in the implementation of experiment. Also, we would like to thank Ali Attar, Kalam Cheung, for their assistance in the field and data work, and the support of University of Southern California Provost's Ph.D. fellowship. This study was funded by EPA under the STAR program through grant RD-8324-1301-0 and by California Air Resources Board through ARB Contact 05-317 to the University of Southern California.

Appendix. Supporting information

Supporting information associated with this paper can be found, in the online version, at doi:10.1016/j.atmosenv.2010.05.033

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ENVIRON

Date: September 2, 2009

MEMORANDUM

To: Mark Stehly

From: Rob Scofield and Linda Hall

Subject: **Draft Environmental Assessment for the BNSF Intermodal Facility Proposed by BNSF Railway Company near Gardner, in Johnson County, Kansas**

This memorandum addresses two broad issues either raised in or implicit to the comments on the **Draft Environmental Assessment for the BNSF Intermodal Facility Proposed by BNSF Railway Company near Gardner, in Johnson County, Kansas** (EA) submitted by Andrea Hricko (University of Southern California) and by the Natural Resources Defense Council (NRDC) specifically:

1. The reasons that health risks calculated for railyards in California are not directly applicable to the Gardner, Kansas facility; and
2. The reasons USEPA cited for their conclusion that the approach adopted by California for quantifying cancer risk is not valid.

In the following discussion, we address each of these issues in turn.

1. **The reasons that health risks calculated for railyards in California are not directly applicable to the Gardner, Kansas facility;**

   Expanding on the comments by Harold Holmes of California's Air Resources Board (CARB) (Kansas City Star, 2007) on this topic, we note that the physical features of any air emission source have an important influence on the estimated air concentrations and health risks. In particular, the proximity of houses to specific rail yard operations will have substantial influence on the risks estimated for the Maximally Exposed Individual (MEI); and when discussing estimated risks for rail yards the estimated risk at the MEI is the value most commonly cited. Estimated risks are also dependent on specific assumptions for emissions, dispersion, exposure and toxicity of chemicals. For any particular evaluation, the selection of these assumptions is guided by local regulatory authorities. California has specific assumptions that must be used for emission factors, dispersion modeling, exposure frequency, and toxicity of chemicals (e.g. diesel exhaust). Some of the assumptions required for use in California differ substantially from the USEPA guidelines used for the Gardner evaluation. Accordingly, estimated health risks for identical facilities in California and Kansas would be quite different because of the distinct set of guidelines used in each analysis. Simple ratios between the number of lifts and estimated health risks, such as are discussed in comments on the EA, are not valid.

   Among the more important specific factors rendering invalid the use of ratios between measures of throughput (e.g., numbers of lifts) and estimated health risks are the fact that each railyard is distinct with respect to the local meteorological conditions, the type of equipment used, the activity patterns of the equipment, and the location and number of people who work or live in the vicinity or each yard Additionally, California calculates cancer risk from DPM based on an approach that has been rejected by the USEPA. These differences are discussed below.

Meteorology. The local meteorologic conditions in the vicinity of a railyard, such as predominant wind speed and direction, temperature, barometric pressure, and cloud cover (as well as the variability in each of these factors), are key determinants of any potential health effects associated with the yard. These factors are important in that the local meteorology governs the direction that emissions might be carried and the extent of their dispersal. Because of the significance of these parameters to health effects estimation, the USEPA has strict meteorologic data requirements for modeling emissions. These requirements are for one-year or five years of representative data on each of the aforementioned parameters, depending on whether the data were obtained on-site or off-site, respectively (USEPA, 2005). Meteorological data cannot be extrapolated between railyards (or between any other facility) unless they are in direct proximity to each other. Consequently, it is clear that extrapolation of such data between California and Kansas - states with dramatically different climate and meteorological regimens - is not supported (USEPA, 2004a,b; 2005). The statement that,"[s]ince the wind at the Gardner IMF proposed location apparently blows toward the town of Gardner, including toward a subdivision and two schools within a mile of the proposed IMF, there is every reason to believe that there will be elevated cancer risks as a result of the Gardner IMG (sic)", has no technical merit, cannot be substantiated, and is contradicted by the emission estimation, dispersion modeling, and health evaluation that was completed and included in the EA.

Equipment Usage and Activity. Commensurate with their individual design and geographic location, each BNSF railyard is used to conduct either different activities or a different combination of activities, and each uses a unique mix of equipment as a consequence. These differences have a substantial impact on the emissions from a railyard, making direct comparisons between yards invalid. For example, compared to BNSF's San Bernardino facility, the Argentine intermodal facility has approximately one-third fewer lifts, and compared with BNSF's Hobart yard about 70% fewer lifts. The Argentine intermodal facility has less classification and train building activity compared to other intermodal facilities, so the switching engines have fewer hours of activity relative to the number of lifts. Additionally, the majority of the arriving and departing trains at the Argentine facility are of the "setout" type, which only stop to cut off rail cars before moving on. This reduces the line-haul locomotive activity, especially idling, compared to San Bernardino or Hobart. Also, there are very few refrigerated containers with auxiliary diesel engines operating at Argentine. Lastly, while Argentine activity levels have been used to project future lift levels at the proposed new intermodal facility, the new facility will have several design features that will minimize emissions compared to even Argentine. These include electric overhead cranes, automated gate technology for truck arrivals and departures, and long tracks to accommodate whole trains, thus minimizing switch locomotive usage.

Impacted Communities. Any calculated impacts from a railyard are also a function of the proximity and number of individuals in the vicinity – factors that are unique to each railyard, and which preclude direct comparisons of health effects between yards. For example, Harold Holmes of the CARB has noted (Kansas City Star, 2007) that the CARB estimated relatively high cancer risks from the BNSF San Bernardino yard because individuals lived in the immediate vicinity of concentrated emissions. However, higher emissions at the BNSF Barstow yard did not have comparable risks because emissions were dispersed prior to reaching the local community.

Furthermore, many of the health studies cited by Ms. Hricko and the NRDC as evidence of railyard-related health impacts are studies of populations exposed to multiple sources of industrial and transportation-related emissions (e.g., freeways) and photochemical smog in southern California, and the implication that the health effects observed in these studies can be attributed to emissions from one or more intermodal railyards in southern California is misleading. To further imply that such health effects could be expected from a single intermodal railyard in Kansas, or anywhere else, is even more misleading.

To address the noncancer health effects of diesel exhaust, the USEPA has developed a Reference Concentration. As shown in the EA, the exposure to diesel exhaust from the Gardner facility would be less than the USEPA exposure limit designed to prevent noncancer health effects (i.e. the Reference Concentration).

<u>Calculation of Cancer Risks</u>. For reasons explained in more detail below, the approach required in California for estimating cancer risks from diesel emissions was explicitly rejected by the USEPA as a valid way to evaluate cancer risks from diesel emissions. Because California's approach to estimating cancer risk is not accepted outside of California, any comparison of cancer risks from California rail yards to the Gardner facility is not applicable.

2. **The reasons USEPA cited for their conclusion that the approach adopted by California for quantifying cancer risk is not valid.**

Diesel exhaust is a complex mixture of hydrocarbons, particulates, gases, water, and other compounds (the precise composition of the mixture depends on many factors, including the fuel source, engine type, engine age, and operating condition). For both the USEPA and California, the general approach to estimating cancer risk from exposure to mixtures - such as combustion exhaust - is to select a subset of so-called indicator chemicals (e.g., the principal components of the exhaust), multiply the estimated concentration of each by a chemical-specific cancer slope factor (CSF), and then add the risks estimated for each indicator chemical. That is, the sum of the health risks from each individual chemical is used as an estimate of the risk posed by the mixture as a whole. Under current USEPA risk assessment practice this approach is used, for example, when estimating health risks from combustion of fuels such as gasoline, fuel oil, wood, natural gas, etc. While California also generally relies on this indicator chemical approach for quantifying cancer risks from mixtures, they have developed an alternative approach for quantifying cancer risks from diesel exhaust. In contrast to the approach used for other mixtures, California developed a CSF to represent the carcinogenicity of the entire mixture of chemicals in diesel exhaust, using diesel particulate matter (DPM) as a surrogate for that mixture (Office of Environmental Health Hazard Assessment [OEHHA], 1998). Both California and the USEPA have adopted a concentration limit of 5 ug/m^3 for diesel exhaust particulate matter (DPM) as a way to evaluate the noncarcinogenic health effects of diesel exhaust.

California's CSF was developed from epidemiology studies on rail road workers in which quantitative correlations were drawn between exposure to diesel exhaust and the incidence of lung cancer. Whether these epidemiology studies are adequate to support development of a CSF for diesel exhaust, using DPM as a surrogate, is the central issue in the different approaches used to quantify diesel exhaust-attributable risk by California and the USEPA.

One of the studies central to California's analysis was that of Garshick et al. (1988). The Garshick et al. (1988) study represents a retrospective analysis of 55,407 white male railroad workers from across the U.S. The lung tumor incidence for these railroad workers was reported in Garshick *et al.* (1987, 1988) and the estimated exposures were reported in Woskie *et al.* (1988a,b).

The USEPA (2002) identified a number of limitations in the Garshick et al. (1988) data, including:

- inadequate information on exposure to diesel exhaust (i.e., assigning who was exposed and who was not exposed),
- lack of knowledge of when workers first began working with diesel equipment, and
- lack of information on smoking and other lifestyle correlates of lung cancer risk.

Of particular concern to the USEPA, to Dr. K. Crump (1991, 1999, 2001) and to the members of an expert panel[1] was the fact that lung cancer risks among the exposed workers decreased with increasing length of exposure – the opposite biological effect from what is expected for a carcinogen. Additionally, one of the categories of workers potentially exposed to high levels of DPM (shop workers), had no elevated cancer risk. Because of these findings, the USEPA has not adopted a CSF (or unit risk factor) for diesel exhaust emissions, stating that, "the available data are too uncertain at this time" (USEPA 2002).

We note that Garshick subsequently published the results of a longer follow-up study of the same workers and found the same trend (Garshick et al., 2004) - suggesting that the original observation of a negative correlation between exposure and lung cancer risk was not an artifact attributable to a truncated follow-up period. Despite the passage of seven years since the original analysis, the USEPA has not revised its position on the adequacy of available data on DPM, has not developed a CSF (USEPA, 2009), and has not adopted California's CSF for DPM.

While the USEPA approach to estimating health risks for mixtures is as discussed above, the USEPA and several states have elected to address the carcinogenicity of diesel exhaust by promoting emission reducing technologies without quantifying cancer risks.

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September 2, 2009

Mark Stehly
BNSF Railway Company
Assistant Vice President Technical Research and Development
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Fort Worth, TX 76131

RE: BNSF Intermodal Facility, Gardner, KS

Dear Mr. Stehly:

At the request of BNSF Railway Company, the Center for Toxicology and Environmental Health, L.L.C. (CTEH) is pleased to have the opportunity to review and comment on many of the toxicological issues that have been raised regarding potential health risks of the proposed intermodal facility near Gardner, KS. In particular, our review addressed comments provided by Andrea M. Hricko (Community Outreach and Education Program (COEP) of the Southern California Environmental Health Sciences Center) and Melissa Lin Perrella and Andrew E. Wetzler (National Resources Defense Council (NRDC)). Our comments are summarized below.

Acute health effects of diesel exhaust

Concerns have been expressed regarding the potential health effects of increased exposure to diesel exhaust as a result of increased traffic at the facility. At sufficient concentrations, exposure to diesel exhaust in air may be associated with various acute symptoms such as irritation of the eyes, nose, throat, and lungs, headache, lightheadedness, cough, and nausea (USEPA, 2002). In general these symptoms are transient and resolve quickly once an individual is removed from the exposure. Excessive exposures to diesel exhaust also have the potential to aggravate pre-existing respiratory problems such as asthma or chronic obstructive pulmonary disease (COPD). As with any chemical exposure, the key factor as to whether acute health effects will occur is based on the magnitude of exposure including the concentration in air and the duration of exposure. In terms of community exposures, predominant wind direction and distance from the source are key considerations in determining potential exposure levels as well.

In reviewing comments by the COEP and NRDC, we note that there is little or no discussion of the potential exposure levels to diesel exhaust that may result from the proposed facility. However, repeated references are made to studies which were performed by the California Air Resources Board (CARB) in their past evaluations of California railyards. For example, Ms. Hricko noted that the highest cancer health risks [and thereby the highest exposure levels] were found at the San Bernardino intermodal facility. In the risk assessment for this facility, it was noted that the hazard indices for non-cancer chronic risk health hazards were 0.05-0.3 (CalEPA, 2008). CARB noted that health hazard indices which are less than 1.0 are unlikely to be associated with potential non-cancer chronic public health risks. In this situation, CARB suggested that it was more reasonable to examine potential cancer risks rather than acute or chronic non-cancer risks.

CARB used a reference concentration of 5 μg/m^3 for inhalation exposure and noted that adverse health effects are not expected with exposures at or below this level. Furthermore, CARB notes that "it should be emphasized that exceeding the chronic reference exposure level does not necessarily indicate that an adverse health impact will occur." The hazard index is calculated by dividing the air concentration by the reference concentration. Calculated diesel PM levels for the San Bernadino risk assessment were thus 0.25-1.5 μg/m^3. Curiously, the estimated average statewide exposure to diesel PM_{10} for California in 2000 was 1.8 μg/m^3 (CalEPA, 1998)

The USEPA also used 5 μg/m^3 as a reference concentration for diesel PM exposure (IRIS, 2009). USEPA defines the reference concentration as "an estimate (with an uncertainty spanning perhaps an order of magnitude) of a daily inhalation exposure of the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime." In other words, the estimated diesel PM concentrations associated with the San Bernadino railyard were well below levels that are considered safe for a lifetime of exposure. In short, it is not reasonable to conclude that diesel PM would be associated with health effects in residents located near the railyard or by inference, a similar facility. These findings are not consistent with the NRDC suggestion that exposure to diesel PM in these circumstances will result in an increase in non-cancer health effects.

Carcinogenicity of diesel exhaust

Many of the comments regarding the proposed facility focused on potential cancer risks due to increased diesel exhaust exposures. In particular, Ms. Hricko noted that: "The EA fails to describe elevated cancer risks at other railyards including at numerous BNSF railyards in California" and that the highest risks were found at the intermodal facility in San Bernadino. Also, the California railyard risk assessments showed elevated levels of cancer risk extending more than one mile. The NRDC notes that while it is difficult to predict cancer risk, "data obtained from California railyards suggests, at the very least, that railyards of similar size and operations (and smaller) to the Proposed Project have been known to create significant health impacts." Extrapolation of the CARB risk assessment studies to the intermodal facility are problematic for a number of reasons and should not be directly applied.

First, the carcinogenicity of diesel exhaust has not been definitively established. Although the state of California considers diesel exhaust to be a known carcinogen, other public health agencies do not concur with such a strong conclusion. For example, the USEPA (2009) has noted that diesel exhaust is likely to be carcinogenic but identifies a number of limitations in determining the overall strength of the association. They note that while some animal studies have shown lung tumors with diesel exhaust exposure, effects have occurred in species which are more susceptible to tumors and occurred at relatively high exposure levels (i.e., >3500 μg/m^3) which are "far beyond the range of environmental levels." USEPA concludes that "The rat tumor occurrences, thus, are not particularly influential in judging the hazards at environmental levels of exposure." While a number of studies examining the association between *occupational* exposure to diesel exhaust and lung cancer have reported a small increased risk (i.e., relative risk typically less than 2.0), the studies are difficult to interpret due to poor exposure assessment and inability to eliminate potential confounding effects of smoking. Relative risk refers to the ratio of illness in the exposed population compared to an unexposed population. In contrast to California, the USEPA (2002) concluded that the diesel exhaust human exposure-response data are considered too uncertain to derive a confident quantitative estimate of cancer unit risk.

Assuming that diesel exhaust can cause lung cancer, it should be noted that studies which reported an association examined individuals with increased occupational exposures. Such exposures are not likely for individuals located at a remote distance from the source. Even under occupational exposure conditions, the relative risks in nearly all studies were significantly less than 2.0. The significance of relative risks less than 2.0 are regarded by epidemiologists as difficult to interpret due to the inability to reliably eliminate confounders. In the case of diesel exhaust and lung cancer, the biggest confounder is cigarette smoking. Occupational groups such as railroad workers and truck drivers which have been studied regarding diesel exhaust exposure and lung cancer are known to have high rates of smoking.

Second, risk assessments such as those performed by the CARB are not intended to prove that living near a railyard actually results in increased lung cancer rates. Furthermore, risk assessments of this type do not establish that railyards "have been known to create significant health impacts." In the CARB risk assessments, diesel exhaust exposure levels for residents living near the railyards were not measured and only estimated based on source emission estimates. A controversial cancer slope factor derived by the state of California was then applied to the exposure estimates to derive the potential number of cancer cases. Extremely conservative exposure assumptions were used such as exposure for 70 years, 24 hours a day, 7 days a week. Finally, there have been no published studies to determine whether residents living near the railyards actually have an increased rate of lung cancer. In short, the risk assessment information cannot be used to "prove" that living near a railyard or that diesel exhaust exposure actually causes increases rates of lung cancer.

Garshick studies

Much of the impetus for California's designation of diesel exhaust as a carcinogen are based on studies conducted by Garshick et al. beginning in the late 1980's. Garshick et al. (2004) was also cited by Ms. Hricko as evidence of the carcinogenicity of diesel exhaust. Due to the heavy reliance on the Garshick railroad study and its conclusions regarding diesel exhaust and cancer, it is reviewed below.

Garshick et al. (1988, 2004) examined lung cancer rates in a cohort of railroad employees who were age 40-64 in 1959 and had been employed for at least 10 years. Lung cancer rates in workers such as conductors and engineers, who were considered to have the highest exposure, were increased with a relative risk generally <1.5. In terms of relative risks, this is not a particularly strong association. For comparison, studies of lung cancer and smoking typically show relative risks for lung cancer 10 or more times higher than this. Younger workers tended to have a higher risk of lung cancer which was attributed to increasing use of diesel locomotives starting in the 1950's. Primary weaknesses of the study included a lack of exposure assessment for the employees, the absence of a clear dose-response relationship, and no information on smoking for the identified lung cancer cases. Although the studies claim to have controlled for smoking, smoking data was actually obtained from a different cohort of workers in which the next-of-kin were asked about smoking histories. This information was then applied to the study cohort and introduces significant sources of error and misclassification.

The lack of accurate information on known smoking rates in the study group is a glaring weakness. Railroad employees from the study timeframe were known to have extremely high smoking prevalence rates. Sterling and Weinkam (1976) reported in a 1970 survey that railroad conductors and engineers were among the 40 occupational categories with the highest percentage of smokers. A previous study by Garshick et al. (1987) of railroad retirees with more than 10 years of experience showed that 96% of the lung cancer cases were smokers and over 80% of the railroad worker controls were also smokers. In addition, over 90% of the cases and controls in which smoking information was available had smoked more than 20 years. Thus, smoking and even passive cigarette smoke exposure to individuals working alongside smokers is a significant confounder, particularly given the finding that lung cancer relative risks associated with exposure to passive cigarette smoke is similar to that reported in the Garshick studies for diesel exhaust exposure. In that time period, workers could smoke while on duty. Many of the other epidemiological studies which are often cited in support of an association between diesel exhaust and lung cancer, such as studies of truckers, suffer from the same limitations of limited exposure assessment and minimal, if any, information on smoking.

Smoking is estimated to account for 90% or more of all cases of lung cancer. Because it is such a strong confounder, Covey and Winder (1981) have noted that "an appropriate evaluation of an occupationally related disease also affected by smoking must include detailed and comprehensive smoking data." Speizer (1986) noted that "Because of the overwhelming effect of cigarette smoking, population-based studies that report on environmental effects, particularly at relatively low levels of excess risk (RR greater than 1.0 but less than 2.0), and that do not attempt to take cigarette smoking into account, must be considered seriously flawed. These studies, therefore, can contribute very little to our understanding of risk factors for respiratory cancer."

Additional perspective on the problem of smoking as a confounder in studies finding weak associations was provided by Sir Richard Doll, a renowned epidemiologist who stated that: "Lung cancer, of course presents a peculiarly difficult problem, because of its close dependence on cigarette smoking and the way smoking habits vary with geographical region and socioeconomic status...Unfortunately it is seldom, if ever, possible to assess the quantitative contribution of this factor to differences in the risk of lung cancer in different occupations, as we neither know the relative importance of smoking habits at different ages nor, if we did, do we usually have smoking histories available in sufficient detail to enable them to be taken into account. Nor is it likely that such detailed histories could now be obtained with sufficient reliability to enable them to be used, once an alternative explanation is known to be suspected" (Doll, 1985).

One of the factors that appears to be overlooked in the Garshick studies has been the association of increasing lung cancer rates which corresponded with increasing cigarette consumption in the U.S. after World War II. The Garshick cohort has been noted to show lower lung cancer rates in older workers who were employed in 1959 compared to their younger coworkers. The higher lung cancer rates in the younger workers were attributed to increased dieselization of the locomotive fleet around this time frame and increased opportunity for exposure to diesel exhaust while operating the diesel locomotives. However, 1959 also corresponds almost exactly to the peak prevalence of smoking in the U.S. (See Figure 1). The marked rise in lung cancer rates after 1950 closely parallels the increased cigarette consumption rates during that era (Figure 2). Thus, given that the actual smoking rates in the study participants were unknown, increased rates of lung cancer in younger workers from the cohort may be due to increased rates of smoking rather than a diesel exposure effect.

Hesterberg et al. (2006) noted similar weaknesses in their review of the literature on diesel exhaust exposure and cancer. They also note that studies of underground miners, who experience the highest occupational diesel PM exposures, generally do not show elevations in lung cancer. They concluded that "After decades of research involving numerous epidemiologic studies and extensive investigations in laboratory animals, a causal relationship between diesel exhaust exposure and lung cancer has not been conclusively demonstrated." Their conclusions were essentially the same as Muscat and Wynder (1995) who also reviewed the association between diesel exhaust and cancer and concluded: "Using common criteria for determining causal associations, the epidemiologic evidence is insufficient to establish diesel engine exhaust as a human lung carcinogen."

In summary, although California has chosen to regulate diesel exhaust as a known carcinogen, the evidence is far from convincing and is based largely on studies, including those by Garshick et al. with significant limitations.

Figure 1. Prevalence of Smoking in the U.S. by decade (from Slade, 1989)

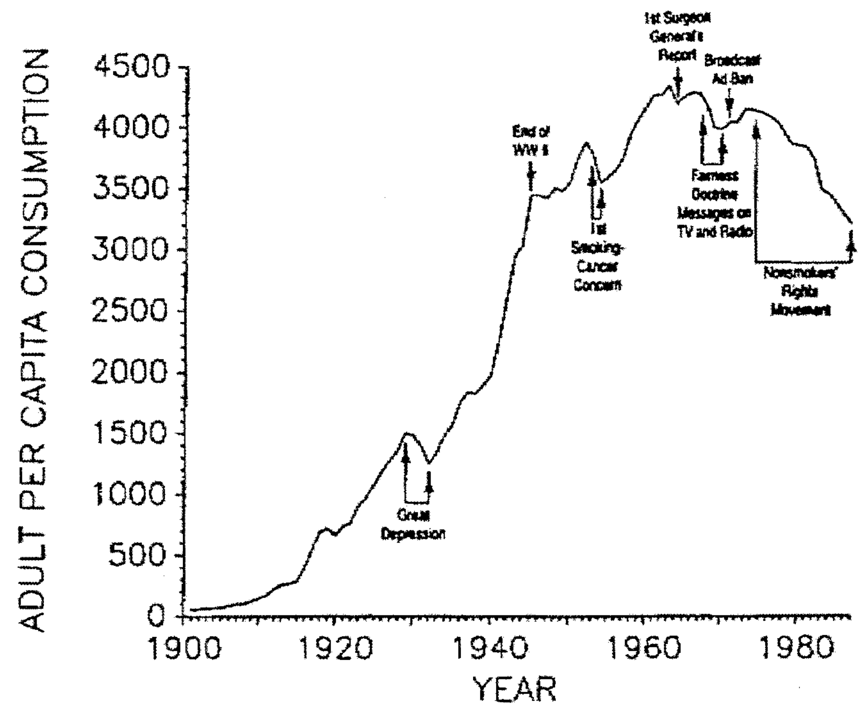
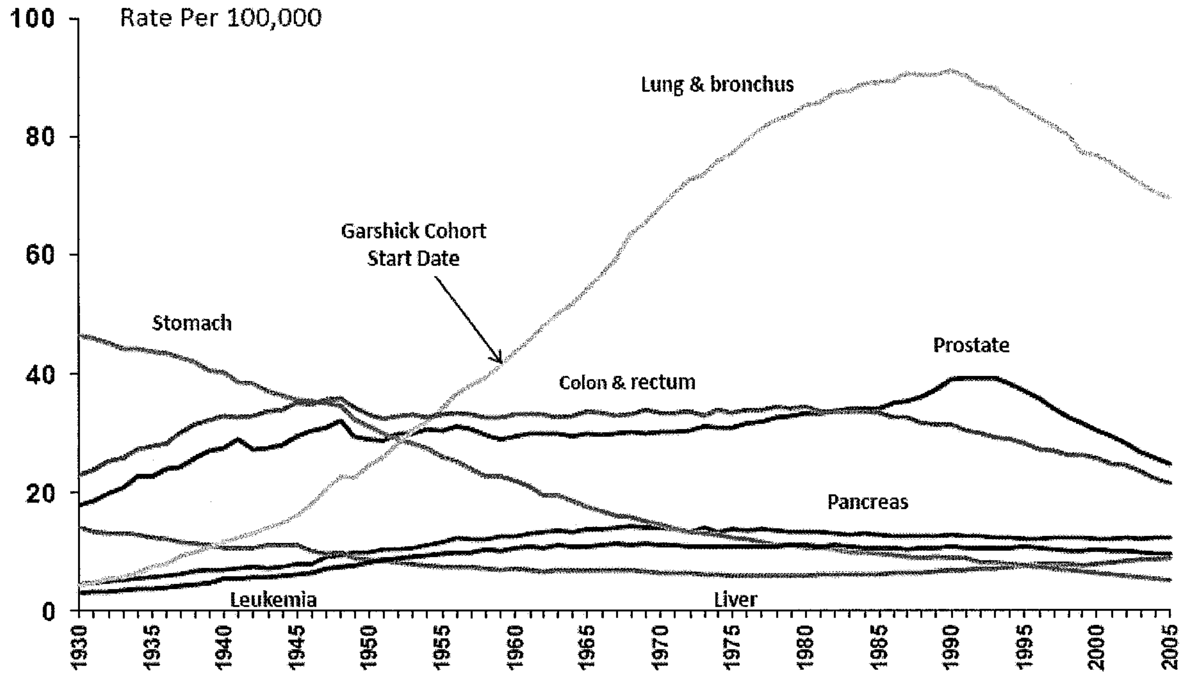


Figure 1. Per capita cigarette consumption, ages 18 and over, and major smoking-and-health events affecting the curve. Adapted from: Warner, K.E. 1985. Cigarette advertising and media coverage of smoking and health. *New England Journal of Medicine* Vol. 312: 384-388.

Figure 2. Cancer death rates among U.S. males, 1930-2005 (from ACS, 2009)



Misleading statements regarding "cancer"

Reviewed comments have repeatedly suggested a link between diesel exhaust exposure and cancer. It should be noted that there are over 100 different types of cancer and the risk factors for each type of cancer are different. It is inappropriate to suggest that exposure to diesel exhaust will increase the rates of cancer in general in an exposed population. As discussed above, studies have primarily examined the association between diesel exhaust and lung cancer. Lung cancer is the most common cancer in U.S. adults. The overwhelming strongest risk factor for lung cancer is cigarette smoking which accounts for 90% of more of all cases. Relative risks of lung cancer due to smoking show an extremely strong and consistent relationship which has not been shown with studies of diesel exhaust. Diesel exhaust exposure is not a known cause of other types of cancer. There are no known studies which have shown an increase in lung cancer rates or cancer in general from diesel exhaust exposure among non-occupationally exposed individuals. It is misleading to insinuate that exposure to increased levels of diesel exhaust from the proposed facility will result in an increase of various other types of cancer.

Other non-cancer health effects

NRDC has suggested that railyards of comparable or even smaller size to the proposed facility have been known to create significant public health impacts. However, the specific health impacts at issue are not specifically defined by NRDC. As noted above, the California risk assessment studies were theoretical evaluations which did not identify a "known" health impact in surrounding communities. In addition, the risk assessments noted that the diesel exhaust exposure levels were significantly less than the reference concentration for non-cancer health effects and would not be expected to result in any adverse health effects, even with the conservative assumption of a lifetime of exposure, 24 hours a day, 7 days a week. Although comments have provided a number of inferences to increased levels of PM from the facility and their potential association with various health effects, the data cited in the California risk assessment does not necessarily support this observation or that PM levels in the community will be increased to levels of concern. It should be remembered that PM can be derived from many sources including automobile exhaust, wood burning, agricultural activities, and others. Epidemiological studies regarding PM and health effects may include PM from multiple sources other than diesel exhaust.

Review of cited studies regarding non-cancer effects

Ms. Hricko has provided a number of references to support her comments regarding the association between air contaminants and various health outcomes such as asthma, cardiovascular disease, diabetes, and low birth weight. Review of these studies indicates they have limited applicability in assessing the Kansas facility. For example, multiple studies were cited in which health effects were examined among children and/or adults living in several Southern California communities in close proximity to Los Angeles (i.e., Gaudereman et al., 2004; Gauderman et al., 2005; Gilliland et al., 2001; Kunzli et al., 2005; McConnell et al., 2006; Salam et al., 2005; Wilhelm and Ritz, 2005). However, no data was provided to indicate that exposures at the proposed facility are comparable in magnitude to that which occurs in the Southern California area secondary to the high of density freeways, vehicular traffic, and the meteorological and topographical conditions unique to that region that result in the familiar smog layer.

Several of the cited studies noted airborne pollutant levels decrease markedly within 150-300 meters of a busy roadway. In fact, McConnell et al. (2006) reported that the effect of the freeway on asthma was only seen in long term residents living within 75 meters of the roadway. Furthermore, this risk was not seen in boys for unknown reasons and suggests a weak association. Kan et al. (2008) noted that the contribution of ultrafine PM from highway traffic becomes indistinguishable from background concentrations at distances >300 meters. These observations are not consistent with CARB health risk assessments claiming increased health risks at increased distances from a railyard. As discussed previously, the CARB assessments were not based on actual air monitoring data showing that air contaminants were elevated at increased distances from a railyard facility. The above studies indicate that it is not plausible to assume that railyard activities would result in increased airborne chemical concentrations (and associated health effects) far off-site.

In terms of respiratory effects and their relationship to vehicular traffic, it is noted that a relationship has not been consistently identified. In fact, one of the studies cited by Ms. Hricko (i.e., Oftedal et al, 2009) notes that a causal relationship between long term exposure to traffic and asthma is so far not clear. In their study of asthma and association with traffic-related exposures they concluded: "We were not able to find positive associations of long-term traffic-related exposures with asthma onset or with current respiratory symptoms in 9- to 10-year-old children in Oslo." They further note that "Thus it is not clear whether air pollution can induce development of asthma, and we speculate that higher levels of exposure than was present in Oslo may be needed."

Specific exposures noted in some of the studies cited by Ms. Hricko as having health effects also do not appear relevant to the proposed intermodal facility. Gilliland et al. (2001) examined school absenteeism in Southern California children and attributed an effect primarily to ozone. Effects of NO_2 on school absenteeism were not observed at the levels measured in the communities. The authors further noted that "little evidence exists that symptoms from NO_2 exposure result in school absences." Ozone has not been specifically identified as a significant substance of concern for the intermodal facility. Wilhelm and Ritz (2005) and Salam et al. (2005) reported an association between carbon monoxide levels and either preterm birth and low birth weights. Carbon monoxide has not been specifically identified as a significant substance of concern for the intermodal facility. High levels of carbon monoxide are not typically associated with diesel engines in comparison to gasoline engines.

Several studies were cited regarding a possible association of air contaminants or other factors with cardiovascular disease. Babisch et al. (2005) was listed in relation to a possible association between traffic noise and myocardial infarctions in Berlin residents. Although an odds ratio of 1.3 for men exposed to sound levels more than 70 decibels during the day was reported, it was not statistically significant. Men who had lived in the area for at least 10 years had a slightly increased risk. However, such a risk was not seen in women which makes the association questionable. Regardless, evidence that the facility would result in noise exposure to this degree in residents living remote from the facility was not presented.

An animal study regarding exposure to ultrafine particles and the occurrence of early atherosclerotic lesions was cited (Araujo et al., 2008). However, it was noted that the exposures in this study were at levels 2-6 times higher than those typically experienced by commuters on Los Angeles freeways. Hartz et al. (2008) was also cited in support of a cardiovascular effect. The study involved direct exposure of brain capillaries from killed rats to diesel exhaust particles and has little practical relevance.

Pope et al. (2004) was cited as evidence of increased cardiovascular mortality due to exposure to fine PM. In the study, the authors reported that a 10 $\mu g/m^3$ increase in fine PM averaged over several years was associated with an 8-18% increase in cardiovascular mortality risk. No evidence was presented that the proposed BNSF intermodal facility would result in PM increases of this magnitude off-site. Similarly, Kunzli et al. (2005) examined atherosclerosis among Los Angeles residents and noted the annual mean $PM_{2.5}$ was 20.3 µg/m3. Kan et al. (2008) reported a small increase in coronary heart disease for individuals living within 300 meters of major roads compared with those living further away (i.e., hazard ratio of 1.12) but was not statistically significant. As noted above, they found that ultrafine PM levels from highway traffic became indistinguishable from background concentrations at distances >300 meters.

Lucking et al. (2008) and Mills et al. (2007) were cited as evidence of a cardiovascular effect. In these studies, volunteers were exposed to relatively high concentrations of diesel exhaust (300-350 $\mu g/m^3$) for an hour and blood clotting characteristics subsequently examined. No evidence was presented that the proposed intermodal facility would result in diesel exhaust exposures of this magnitude. As noted above, community diesel exhaust exposures estimated in the CARB studies were orders of magnitude lower than those examined in the Lucking and Mills studies.

In summary, studies cited in the respondent's comments have limited, if any, applicability to the proposed facility based on the circumstances of the studies, levels of exposure, and/or examined substances.

SUMMARY

- Exposure to sufficient levels of diesel exhaust in air may cause irritant and other symptoms. These symptoms are transient and resolve quickly when removed from the source of exposure.
- It is unlikely that diesel exhaust levels in air would be at concentrations sufficient to cause either acute or chronic non-cancer health effects as evidenced by CARB risk assessments which used extremely conservative exposure assumptions.
- Diesel exhaust is not a known cause of cancer.
- Studies which have reported an association between diesel exhaust exposure and lung cancer are difficult to interpret due to weak associations, limitations in exposure assessment, and inability to control for the effects of cigarette smoking.
- Diesel exhaust exposure levels in occupational studies reporting an association with lung cancer are not comparable to those which would occur at a remote location from the source. Airborne chemical concentrations decrease rapidly with increasing distance from the source.
- Studies cited by respondents regarding potential health effects of the facility have limited, if any, applicability based on the circumstances of the studies, levels of exposure, and/or examined substances.

Sincerely,

CENTER FOR TOXICOLOGY AND ENVIRONMENTAL HEALTH, L.L.C.

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The Gateway Cities Air Quality Action Plan

State-of-the-Science for Modeling and Monitoring Ultrafine Particles near Roadways and Implications for Gateway Cities Region

Final

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Glossary of Terms

µm	Micrometer. One millionth of a meter
Background concentration	Concentration of substance in the absence of any significant sources present in the vicinity.
BC	Black Carbon
CARB	California Air Resources Board
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CPC	Condensation Particle Counter
D_a	Aerodynamic diameter
DMA	differential mobility analyzer
D_P	electric mobility diameter
D_s	Stokes diameter
EC	Elemental Carbon
ELPI™	Electrical Low Pressure Impactor
EPA	Environmental Protection Agency
EU	European Union
Exposure	Contact with a substance by swallowing, breathing, or touching the skin or eyes
FMPS™	Fast Mobility Particle Sizer
I/O	Indoor to Outdoor
LA	Los Angeles
LPG	Liquefied Petroleum Gas
Mass Concentration	Total mass of particles in a unit volume of ambient air. Generally expressed as micrograms per m3
MATES	Multiple Air Toxic Exposure Study
nm	Nanometer. One billionth of a meter.
Number Concentration	Number of particles in a unit volume of ambient air. Generally expressed as number per m3 or number per cm3
OM	Organic Matter
Particle Size Distribution	Characterization of particle properties such as number or mass on basis of the particle size

PM	Particulate Matter
PM10	Particles with aerodynamic diameter less than 10 microns
PM2.5	Particles with aerodynamic diameter less than 2.5 microns
PMP	Particle Measurement Program
RIT	Road-induced Turbulence
SCAQMD	South Coast Air Quality Management District
SEM	Scanning Electron Microscopy
SMPS™	Scanning Mobility Particle Sizer
SO_2	Sulfur Dioxide
SULEV	Super Ultra Low Emissions Vehicle
TEM	Transmission Electron Microscopy
UFP	Ultrafine Particles
Ultrafine particle	Particles generally with aerodynamic diameter less than 0.1 micrometer
UNECE	United Nations Economic Commission for Europe
VIT	Vehicle-induced Turbulence

1. Introduction

Ambient particulate matter (PM) has been linked to numerous adverse health outcomes and remains a major environmental challenge. In recent years, there is increasing evidence of particle size playing a major role in determining the extent of adverse health effects. It has been observed that smaller particles have a higher probability of penetrating into and depositing in lower parts of the human lung and entering the bloodstream than larger particles, which are removed more efficiently by the defense mechanism of the mucociliary system (Daigle et al. 2003). Furthermore, on a mass basis, ultrafine particles have larger surface area and higher oxidant capacity than larger particles. This larger surface area likely enhances the toxic properties of the ultrafine particles. Animal studies in particular have shown increased pulmonary inflammation from ultrafine particles rather than larger particles with the same chemical composition. Therefore, there has been growing interest to better understand the particles in size range less than 100 nanometers (nm), commonly referred to as ultrafine particles.

Although the operational definition of ultrafine particles varies in the scientific literature, it is generally accepted that particles with size less than 100 nm (0.1 µm) are labeled as ultrafine particles. Note that the term nanoparticle is also used often in the scientific literature for particles with sizes on the order of few nanometers, especially in toxicological studies. Although this term is applicable to ambient particles with sizes less than 10 nm, it is applied more often to manufactured nanoparticles rather than those emitted due to human activities.

The health effects of concern from inhaling ultrafine particles include pulmonary inflammation, oxidative stress, and induction of exacerbation of cardiovascular disease (Peters, et al. 1997; Utell and Frampton 2000; Frampton 2001; and Murr and Garza 2009). There remains considerable uncertainty on biological mechanisms and the physiochemical components on the ultrafine particles that lead to these health effects. This remains a very active area of epidemiological research.

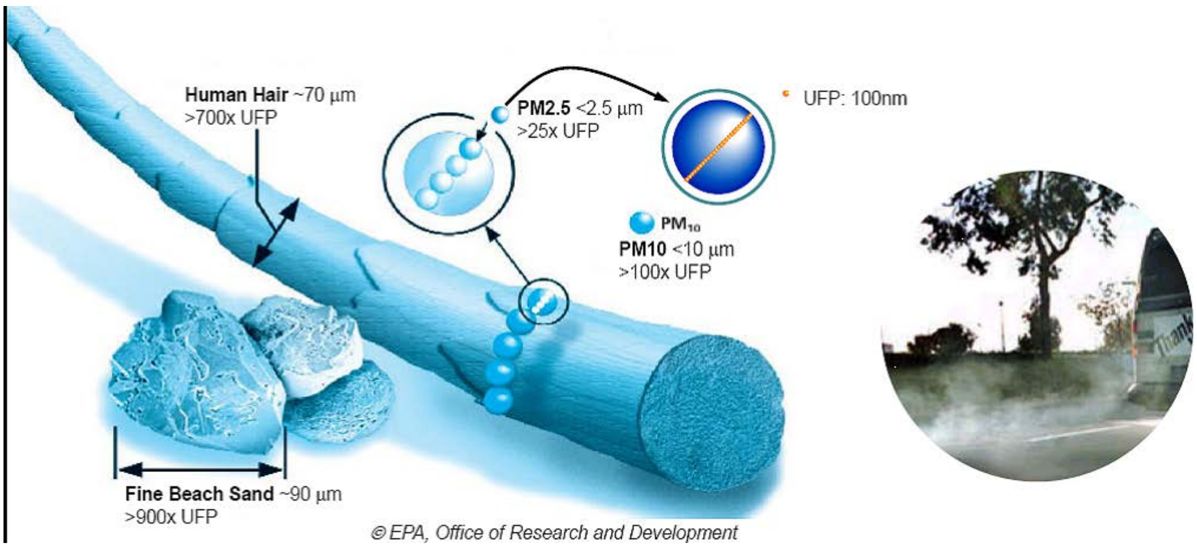
Despite a significant body of suggestive evidence linking ultrafine particles to adverse health effects, there are still many gaps in the knowledge of ultrafine particles to which people are exposed to in the environment. Areas continuing research to improve the understanding of exposure to ultrafine particles include understanding the behavior of the ultrafine particles in the near field and the atmospheric processing of these particles; developing robust measurement techniques and instrumentation; and developing operational protocols to accurately characterize them. The objective is to ultimately advise the public, the environment regulatory community, and other stakeholders in developing effective approaches that reduce exposure to ultrafine particles.

This report is prepared to briefly summarize the latest understanding of ultrafine particles in the context of the Gateway Cities Air Quality Action Plan and is organized as follows. Section 2 describes the characteristics of ultrafine particles and current techniques to measure their ambient concentrations. Section 3 describes emissions and mechanisms of the atmospheric processing of ultrafine particles emitted from vehicle tailpipes. Section 4 summarizes recent monitoring studies performed in the Los Angeles (LA) air basin, identifies major trends, and also presents studies that measure exposure to ultrafine particles in the LA air basin. Section 5 discusses current and prospects for future regulation of ultrafine particles. Finally, Section 6 concludes with a summary of major findings.

2. Characterization of Ultrafine Particles

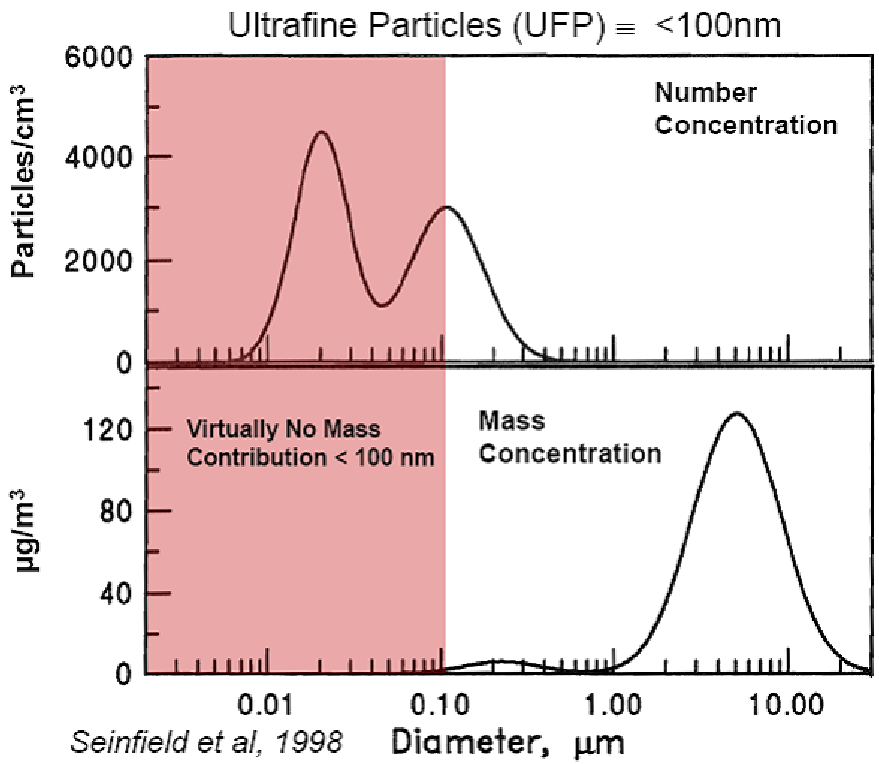
Ambient particles in general are characterized by their size, shape, physical properties (e.g., density, volatility), and chemical composition. For ultrafine particles, the most defining property is their size. As mentioned earlier, ultrafine particles are generally defined as particles with a diameter less than 100 nanometers (nm) or 0.1 micrometers (µm). In contrast, PM2.5 and PM10 consists of particles with diameters less than 2.5 and 10 µm, respectively. Therefore, ultrafine particles are nearly 25 times smaller than PM2.5 and 100 times smaller than PM10 in diameter. Figure 1 illustrates size difference between ultrafine particles, PM2.5, and PM10. Note that PM2.5 and PM10 fractions of the ambient PM also include ultrafine particles based on the above definitions. Currently, the mass concentration of PM2.5 and PM10 are regulated by national and California ambient air quality standards and, for motor vehicles, a mass per mile exhaust emission standard.

Figure 1. Relative Size of Ultrafine Particle (UFP) Relative to Human Hair and Other Particle Sizes



Because of their small size and volume, the aggregate mass of ambient ultrafine particles is not significant compared to larger particles. However, several studies have shown that ultrafine particles dominate the number concentration of ambient PM. For example, Stanier, et al. (2004) showed that 25% of the ambient aerosol particles are less than 10 nm and 75% of the number of particles are less than 50 nm. In contrast, particles larger than 100 nm, i.e. PM2.5 and PM10, primarily contribute to the mass concentration. See Figure 2.

Figure 2. Comparison of Number and Mass Distribution of Ambient Particles



Along with size, chemical composition also influences the toxicity of ultrafine particles. However, the chemical composition of ultrafine particles is even less well understood. This is mainly because a significant variation in chemical composition can be found within various environments, times of the day, and months of the year, depending on the nature and emission strengths of local sources and atmospheric conditions. Organic matter (OM), elemental carbon (EC), and inorganic compounds such as sulfates and nitrates constitute most of the ultrafine particle mass. Other constituents include water, sodium, potassium, and transition metals. EC is considered as a marker of the combustion processes for diesel engines as its major source in urban areas. OM, a mixture of high molecular weight hydrocarbons, is emitted directly from combustion processes and also forms in the atmosphere from gas-phase emissions. OM constitutes a significant fraction of emissions from meat cooking and wood burning. Sulfate in the particles results from sulfur present in the fuel that is oxidized during the combustion process. Similarly, high temperatures during combustion lead to the oxidation of atmospheric nitrogen, which results in presence of nitrates in ambient particles. Some recent studies conducted in southern California region showed that the chemical composition of ultrafine particles ranged from 32 to 69% of OM, 1 to 34% of EC, 0 to 24% of sulfate, and 0 to 4% of nitrate (Sardar et al. 2005; Arhami, et al. 2009).

The United States and California air quality standards for particulate matter are based on mass concentration. Therefore, currently there is no large-scale monitoring network that measures number concentration of ambient particles. Several studies are available in the literature that measured particle number concentration in various outdoor environments. Morawska et al. (Morawska, Ristovski et al. 2008) analyzed 71 measurement studies recently reported in the literature and calculated the mean and median number concentration for eight different environments. As shown in Table 1, the number concentrations are highest in tunnel environments followed by on road and roadside environments. The mean concentrations for these environments are greater by 64, 27, and 18 times respectively than a clean background.

Table 1. Mean and Median of Particle Number Concentrations in Various Environments

Environment	Mean (10^3 Particles/cm)	Median (10^3 Particles/cm)
Tunnel	167.74 (64)	99.09 (31)
On Road	71.45 (27)	47 (15)
Roadside	48.18 (18)	34.58 (11)
Street Canyon	42.07 (16)	39.13 (12)
Urban	10.76 (4)	8.83 (3)
Urban background	7.29 (3)	8.1 (3)
Rural	4.83 (2)	2.91 (1)
Clean Background	2.61 (1)	3.2 (1)
Data source: Morawska et. al. 2008. The numbers in parenthesis show the ratio of the concentration statistic with that of a clean environment.		

2.1. Measurement of Ultrafine Particles

Ambient particles often have variety of shapes (e.g. tubular, irregular, etc.) rather than ideal spherical shape, which can be characterized by only one size parameter (the diameter). Therefore, this poses some difficulties in their mass and number concentration measurement. Aerodynamic diameter (D_a), Stokes diameter (D_s), and electric mobility diameter (D_P) equivalent are often used in the context of the properties of particles moving in air. Aerodynamic diameter is the diameter of a perfect sphere of unit density with same mobility as the particle being measured. Stokes diameter is similar to the aerodynamic diameter, but uses the true density of the particle. Electric mobility diameter is widely used in instruments and defined as the diameter of a perfect sphere of unit density with same electric mobility as the particle being measured.

A recent review by Kumar, et al. (2010) identified several instruments that are commercially available to measure the size distribution of ambient particles, including ultrafine particles. These instruments include the Scanning Mobility Particle Sizer (SPMS™), Fast Mobility Particle Sizer (FMPS™), and Electrical Low Pressure Impactor (ELPI™) that provide size-segregated number concentration. In addition, a condensation particle counter (CPC) is a standard instrument employed in the study of ultrafines to provide number concentration of the entire aerosol population.

The SMPS system is an instrument that uses electric mobility principles to measure the number and size distribution of an inlet aerosol population Kumar, et al. (2010). This instrument mainly consists of three components: 1) A bipolar radioactive charger to charge the particles, 2) a differential mobility analyzer (DMA) to classify the particles based on their electrical mobility, which in turn depends on their size, and 3) a CPC for detecting the particles and providing the number concentration. Some commercially available SMPS include the 3034 TSI (TSI Inc) that measures D_p between 10 and 487 nm for number concentrations in the range of 10^2 to 10^7 particles/cm^3 and takes 180 seconds to analyze a single scan. More recent models (such as the 3934 TSI) can measure a larger range of particle size and with shorter sampling times (30 seconds).

The FMPS is similar to SMPS in principle. However, instead of a CPC, the FMPS uses multiple, low-noise electrometers for particle detection and count. The main advantage of FMPS is that its sampling frequency can be as high as 1 Hz (i.e., analysis of one sample per second), which is partly accomplished by using a high sample flow rate. Therefore, FMPS can be used to characterize fast-changing particle populations.

The ELPI is another instrument that has high sampling rates and measures the size distribution of particles in the range of 30 to 10,000 nm. This instrument uses aerodynamic size classification of charged particles by a low pressure cascade impactor and subsequent electrical detection for particle count. An added advantage of this instrument is that the cascade system allows for other analysis such as chemical composition and further characterization through scanning electron microscopy (SEM) or transmission electron microscopy (TEM) techniques.

As noted by Kumar et al. (2010) several parameters need to be considered before adopting a particular instrument or detection technique to be used in a regulatory or compliance context. These include portability, time response, detection limits, sampling frequency, reproducibility and capability of unattended operation over long duration, and cost and maintenance requirements. Despite technological advancements in recent years that address many of these issues, reproducibility and consistency across various instruments still remains an area that needs additional research and progress. Asbach et al. (2009) used four different particle sizers (two TSI SMPS, one TSI FMPS, and one Grimm SMPS) to analyze NaCl and diesel soot particles and found that each instrument showed repeatable results. However, there was a considerable difference between instruments. Among these four instruments, FMPS consistently showed lower particle size distributions than SMPS.

3. Ultrafine Particles in Near-Roadway Environment

Several studies have shown that motor vehicles are the dominant source of ultrafine particles in the outdoor environment. Furthermore, the concentrations are highest in the near-roadway locations given their proximity to the emission sources. Among motor vehicles, heavy duty diesel engines are shown to emit significantly higher numbers of ultrafine particles than light-duty gasoline vehicles. In general, a heavy duty diesel truck or a bus may emit one or two orders of magnitude higher than a typical light-duty vehicle (Kirchstetter, et al. 1999; Ristovski, et al. 2005).

The number concentration of ultrafine particles at a near-roadway location is primarily determined by the strength of emissions in the surrounding area and atmospheric processing of the emitted particles as they are transported to the location of interest. These two aspects are discussed further below.

3.1. Emissions of Ultrafine Particles from Vehicles

From emissions perspective, ultrafine particles can be classified into either *primary* or *secondary* particles. Primary particles are formed in the engine and tailpipe and are emitted directly into the ambient atmosphere. These particles, mostly agglomerates of solid-phase carbonaceous material, are generally in the size range 30 to 500 nm. As hot gases are released from the tailpipe, they are cooled rapidly in the ambient environment. Consequently, many of the constituent gases with low-volatility condense to form a large number of new particles. These are known as secondary particles and are generally below 30 nm. Secondary particles are largely composed of sulfate, nitrate, ammonium, and organic material.

The first step in quantifying and addressing the extent of vehicle emission contribution to the ambient concentration is characterization of the tailpipe emissions and how such emissions vary with the nature of fuel composition, operating conditions, and control technologies.

Early studies on particulate emissions and fuel composition focused on sulfur content. Sulfur occurs naturally in crude oil and is mostly removed in the refining process, but a small percentage remains in diesel and gasoline fuel. During the combustion, sulfur is oxidized to sulfuric acid and is emitted through exhaust as a volatile material. After leaving the tailpipe, sulfuric acid undergoes condensation or nucleation and contributes to total particle emissions. Dynamometer and on-road measurements have shown that particle number decreases with the sulfur content both in fuel and lubricants. The introduction of ultra low sulfur fuels in California in 2006 and fully phased in nationwide by 2010 has significantly reduced ultrafine particles forming from sulfur condensation and nucleation.

In recent years, various biofuels (both pure and blended) have begun to be used in heavy duty diesel trucks and buses in order to decrease the reliance on imported fossil fuels and also to mitigate climate change. This transition may affect tailpipe emissions. Studies have shown that most heavy duty vehicles powered by biofuels emit a higher number of particles than those powered by diesel (Kumar, et al. 2010). This increase is attributed to the increased nucleation rates in the exhaust of biofuels due to reduced surface area of pre-existing particles and lower caloric content in biofuels requiring the use of greater quantities of fuel compared to conventional diesel fuel. However, it is important to note that the use of biofuels leads to overall reduction in particulate mass emissions due to the decrease in the emissions of solid carbonaceous particles.

Among alternative fuels, liquefied petroleum gas (LPG) and compressed natural gas (CNG) are seen as cleaner than conventional diesel or biofuels and are widely used in the South Coast bus fleet, and they have potential as a widespread replacement fuel for heavy duty trucks. A few studies that have examined these fuels have found that LPG vehicles are shown to emit 70% less ultrafine particles than conventional unleaded gasoline vehicles (Ristovski, et al. 2005). CNG vehicles are known to emit considerably less particle mass than diesel vehicles. Although CNG and LNG buses emit lower number of particles at lower loads compared to diesel buses, both dynamometer and on-road studies have shown that the number of particles emitted by CNG at high loads and during acceleration are an order of magnitude greater than those of diesel buses (Jayaratne, et al. 2010). For CNG buses, emissions of particle number vary by an order of magnitude between low-load and high-load conditions.

As with other vehicle emissions, ultrafine particle emissions from tailpipes may be controlled using the after-treatment devices. Two main classes of these devices are oxidation catalysts and particle traps. Oxidation catalysts mainly remove the soluble organic fraction and have no effect on elemental carbon in the exhaust. Further, these catalysts may oxidize sulfur dioxide (SO_2) to sulfate and may increase sulfate in particle mass and number. Therefore, the effectiveness of these devices depends on the relative chemical composition of the exhaust. Application of oxidation catalysts may actually increase the particle number when used in conjunction with high sulfur-content fuels (Vogt, et al. 2003).

Particle traps have proven to be effective in removing the solid-phase particles, including elemental carbon. However, volatile material (in gas or liquid form at high exhaust temperatures), especially sulfate mass, passes through the filter and acts as a precursor to nucleation-mode particles. Furthermore, by retaining solid-phase particles, particle filters may promote nucleation over condensation thus leading to an increase in the formation of new particles.

3.2. Environmental Fate and Transport of Ultrafine Particles

Almost immediately after the ultrafine particles are emitted into the atmosphere, atmospheric processes govern their fate and transport in the ambient environment and dynamically change their physical and chemical characteristics. Consequently, the temporal and spatial evolution of ultrafine particles, especially their size distribution, depend on the extent of atmospheric processing, which in turn depends on ambient meteorological conditions such as temperature, wind speed, relative humidity, and incident solar radiation.

Once particles are emitted from the vehicle tailpipe, transport by wind is the main mechanism by which emissions are initially dispersed into the atmosphere, resulting in dilution of the exhaust plumes. Turbulent transport, both in the horizontal and vertical direction, dominates the dispersion of pollutants. In general, high wind speeds result in efficient transport of pollutants, leading to lower ambient concentration in the vicinity of emissions sources. Atmospheric stability, a measure of resistance to the vertical motion of air parcels in the atmosphere,[1] also significantly affects the turbulent mixing and resulting dispersion of emissions.

Another distinguishing feature between the dispersion of pollutants from roadway and non-roadway sources is the effect of turbulence generated by vehicles, roadway structures, and noise barriers. The near-roadway turbulence, broadly classified into vehicle-induced turbulence (VIT) and roadway-induced turbulence (RIT), may significantly contribute to the mixing of pollutants, leading to additional dilution of near-roadway emissions (Bäumer, et al. 2005; Kalthoff, et al. 2005). A significant fraction of kinetic energy may be converted into additional turbulence due to the aerodynamic resistance when fast-moving vehicles interact with the ambient air. The turbulence generated strongly depends on the vehicle shape and speed. For example, heavy duty diesel trucks induce more turbulence due to their size and shape than passenger cars. Therefore, reducing congestion and increasing speeds will promote more mixing and lower peak concentration of ultrafine particles.

Road embankments also generate turbulence as they act as the obstacle to the wind flow. The RIT due to embankment depends on the wind speed, direction, and the height and shape of the embankments. Similarly, roadside structures such as noise barriers and vegetation also affect dispersion by creating local turbulence effects (Lidman 1985; Baldauf, Thoma et al. 2008). In addition, the temperature difference between asphalted roadway surfaces and surrounding grassy surfaces creates thermally induced flow, which could affect dispersion of roadway emissions. Finally, in an urban environment, built structures distort the wind field around them and therefore affect the dispersion of pollutants.

Zhang and Wexler (2004); Zhang, et al. (2004); and Zhang, et al. (2005) proposed that the dilution of a vehicle exhaust plume may be considered to occur in two distinct stages. The first is the tailpipe-to-road dilution by the strong turbulence generated by traffic, lasting about 1 to 3 seconds and causing the initial concentration of ultrafine particles to be diluted by up to a factor of 1,000. The second stage is the roadway-to-ambient environment, which further dilutes the concentration of ultrafine particles by about a factor of 10, lasting 3 to 10 minutes. This dilution is due to atmospheric turbulence and advection by the ambient wind. Such large dilution ratios lead to an exponential decrease in the number concentration of ultrafine particles within relatively short distances from a freeway as observed in a number of studies (Zhu, et al. 2002a; Westerdahl, et al. 2005; Morawska, et al. 2008).

As vehicle exhaust plumes are diluted in the atmosphere, three main processes—nucleation, condensation, and coagulation—change the size of the particles in the plume and govern the overall size distribution. Nucleation refers to the formation of new particles with a size generally below 20 nm from super-saturation of low volatility gaseous compounds. However, such super-saturated compounds can also condense onto pre-existing particles, which increases the size of such particles. Thus, nucleation and condensation are two competing processes. The availability of a pre-existing particle surface area

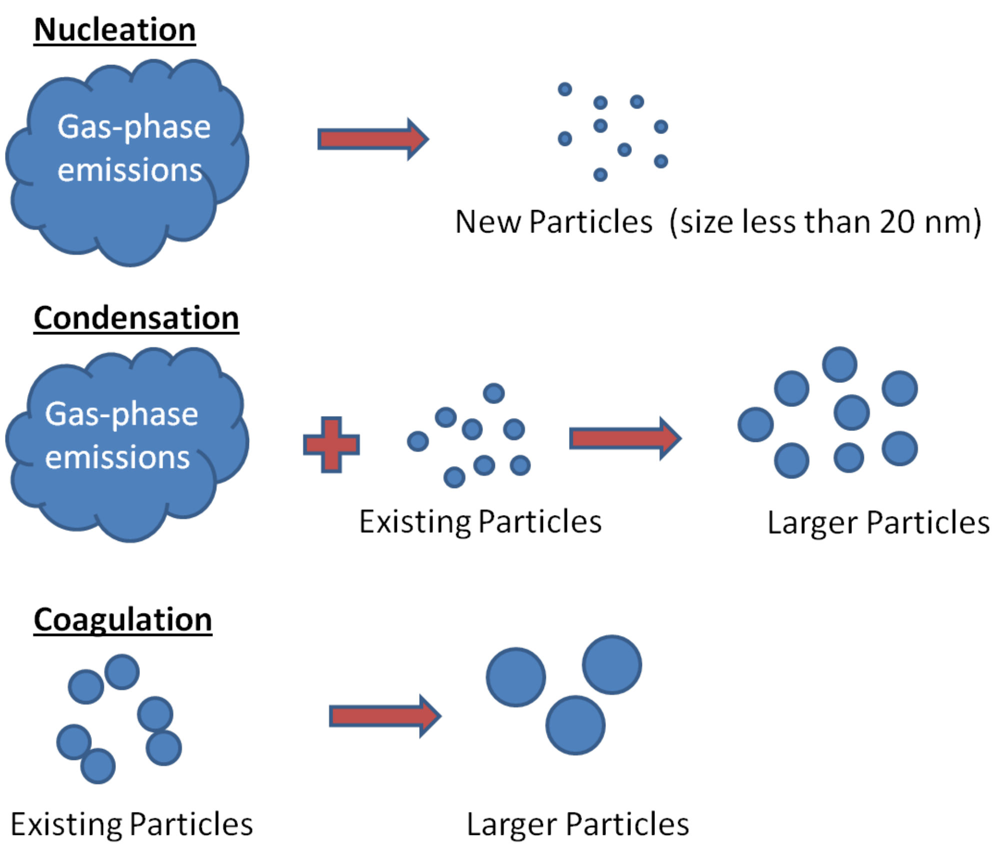
[1] Stability can be broadly classified as stable, neutral, and unstable. Stable atmospheric conditions restrict the vertical movement of air parcels, thus creating conditions conducive for the accumulation of pollutants near the surface. Unstable atmospheric conditions accelerate the vertical movement of air parcels and promote the turbulent mixing of pollutants. Under neutral conditions, the dispersion of pollutants is influenced by both transport and turbulent mixing.

and plume dilution rate determines which of these processes dominates. Polluted urban environments often contain a large number of pre-existing particles to favor condensation over the formation of new particles through nucleation. Coagulation occurs when two or more particles collide and combine to form a new larger particle. Figure 3 graphically illustrates these three processes.

The emissions from the tailpipe of a vehicle containing highly concentrated gas vapors undergoes rapid cooling immediately after leaving the tailpipe, during the tailpipe-to-road dilution phase, and reaches super-saturation, which may result in both the generation of new particles through nucleation and growth of the existing particles through condensation. Such particles, often less than 30 nm in size, have been observed near busy freeways, especially those carrying a large fraction of heavy duty diesel trucks (Zhu, et al. 2002b; Westerdahl, et al. 2005; Ntziachristos, et al. 2007).

The rate of generation of ultrafine particles depends on several factors, including temperature, relative humidity, atmospheric stability, and vapor pressure (Zhang and Wexler 2004; Zhang, et al. 2005). Low ambient air temperatures and high relative humidity favors the formation of new particles as demonstrated in some on-road studies (Ronkko, et al. 2006; Casati et al. 2007). Particles that are generated through nucleation have short atmospheric lifetimes, on the scale of few minutes, because they coagulate with other particles and form new larger particles.

Figure 3. Illustration of Nucleation, Condensation, and Coagulation Processes That Affect the Size Distribution of Ambient Particles



4. Ambient Concentration of Ultrafine Particles in the Los Angeles Area

As the significance of ultrafine particles' possible public health concerns have gained increasing attention in recent years, several monitoring studies have been performed, mostly by academic institutions, to better characterize and understand the ambient concentrations of ultrafine particles, especially in near-roadway environments. This section synthesizes the trends and characteristics of ambient ultrafine particles reported in the scientific literature drawn from studies conducted in the Los Angeles area.

As discussed in the previous section, a distinguishing feature of ultrafine particles is their elevated concentration close to roadways (or emission sources) and their exponential decay with distance from the freeway because of transport and turbulent mixing. This behavior has been confirmed in several field studies conducted in the vicinity of a number of southern California freeways.

Zhu, Hinds et al. (2002a; 2002b) conducted four measurement campaigns to characterize the ultrafine particles in LA area during the summer of 2001 and the winter of 2002. These studies measured the particle number concentration and size distribution in the size range from 6 to 220 nm at various distances from I-405 and I-710. In addition, the mass concentrations of carbon monoxide (CO) and black carbon (BC) were also measured at each sampling location. Black carbon is a close surrogate for diesel PM emissions. Since an identical set of instruments was used and common data analysis methods were applied by the same group of researchers, the bias in configuration and data interpretation is minimized. Therefore, data from these studies can be used to obtain important insights and understanding of ultrafine particle characteristics in the near-roadway environment.

The summertime measurements were conducted 30, 60, 90, 150, and 300 meters downwind and 300 meters upwind for I-405 at the Los Angeles National Cemetery between May 15 and July 18, 2001. For the I-710 study, the measurements were taken at 17, 20, 30, 90, 150, and 300 meters downwind and 200 meters upwind from the freeway in the City of South Gate along Southern Avenue between August 30 and October 27, 2001. Wintertime measurements were taken at the same monitoring sites between January 11 to January 20, 2002, for the I-405 sampling sites and between January 14 and January 25, 2002, for I-710 sampling sites. For all studies, particle measurements were made using a CPC for total number concentration (CPC 3022A; TSI Inc.) and SMPS for size-segregated number concentration (SMPS 3936, TSI Inc.).

The traffic on I-405 is dominated by passenger cars and light-duty vehicles with less than 5% of heavy-duty diesel trucks. In contrast, the heavy-duty diesel traffic on I-710 is often higher than 25%. During the measurement period, the hourly average traffic volume on I-405 was 13,900 vehicles, and more than 93% of these were gasoline-powered passenger cars. A strong correlation was observed between the traffic density and measured total particle concentration for monitoring sites near I-405. For the I-710 study, the hourly average hourly traffic volume was 12, 180 vehicles with heavy trucks constituting nearly 30%. The traffic density during this study has less variation than that of I-405.

As discussed in the previous section, wind plays a major role in the dispersion of emitted ultrafine particles. Due to frequent on-shore winds, the monitoring sites in both studies by Zhu et al. (2002a, 2002b) were downwind of the freeway 80% of the time. Total particle number concentration measured by a CPC located 30 meters downwind from I-405 decreased almost linearly with the wind speed with a correlation coefficient (R^2) value of 0.99. In contrast to this behavior, total particle concentration first increased with the wind speed up to 1.5 m/s and then decreased. This anomaly was attributed to large uncertainty in measurements made when speeds are less than 1 m/s.

The findings from Zhu have important implications for I-710. Prevailing winds along the I-710 corridor in the AQAP study area are from the southeast to east. This will typically lead to the highest ultrafine particle exposure over the Los Angeles River south of State Route 90 (Imperial Highway) where the nearest sensitive receptors on the east side of the I-710 are more than 500 meters from the roadway. North of the State Route 90, where the Los Angeles River is to the west of I-710, the communities of Bell Gardens, Commerce, and East Los Angeles are in much closer proximity to I-710 and are in the prevailing downwind direction.

Despite the difference in the traffic vehicle mix, both studies by Zhu showed some common behaviors. The maximum number concentration that was observed next to I-710 and I-405 is nearly 25 and 30 times that of the background concentration, respectively. However, the number concentration of ultrafine particles near both freeways falls precipitously with the distance and become indistinguishable from an upwind site at 300 meters. In addition, the CO and BC concentrations also decrease at the same rate as particle number in both studies and drop by 60 to 80% within first 100 meters. However, PM mass concentration, measured in the I-405 study decay at a much smaller rate, displays different characteristics from CO, BC and particle number concentrations. This is because direct PM emissions from passenger car emissions contribute a relatively small amount relative to background PM concentration. The CO, BC, and number concentration data is summarized in Tables 2 and 3.

Both studies by Zhu (2002a and 2002b) also analyzed the evolution of size distribution of ultrafine particles in a near-roadway environment using the data collected from SMPS. The size distribution of ultrafine particles sampled at both I-405 and I-710 showed three distinct modes. Zhu (2002b) further examined the number concentration of particles in the following size bins: 6 to 25 nm, 25 to 50 nm, 50 to 100 nm, and 100 to 220 nm. In both studies, the particles in the smallest bin (6 to 25 nm), contribute over 70% to the total number concentration and decrease sharply within first 100 meters from the freeway. This characteristic is attributed to the rate of coagulation and faster diffusion rates of smaller particles.

Table 2. Measured Average Concentrations of Ultrafine Particles, CO and BC at Increasing Distances from I-405

Measurement (m)	30	60	90	150	300
CO (ppm)	2.0 (1.7-2.2)	0.9 (0.7-1.0)	0.6 (0.5-0.7)	0.4 (0.3-0.5)	0.2 (0.1-0.3)
BC (µg/m³)	5.4 (3.4-10.0)	3.2 (3.0-3.5)	2.5 (2.4-2.6)	1.6 (1.1-2.0)	1.3 (1.1-1.5)
Number Concentration (x10⁵/cm³)	1.5 (1.3-1.7)	0.88 (0.77-0.96)	0.70 (0.61-0.85)	0.50 (0.42-0.58)	0.37 (0.30-0.39)
Data Source: Zhu 2002a, 2002b. Range given in parenthesis. Note these concentration include background.					

Table 3. Measured Average Concentrations of Ultrafine Particles, CO and BC at Increasing Distances from I-710

Measurement (m)	17	20	30	90	150	300
CO (ppm)	2.3 (1.9-2.6)	2.0 (1.5-2.4)	1.7 (1.1-1.9)	0.5 (0.2-0.7)	0.4 (0.1-0.5)	0.2 (0.1-0.3)
BC (µg/m³)	21.7 (20.3-24.8)	19.4 (16.5-21.6)	17.1 (12.6-19.3)	7.8 (4.5-9.3)	6.5 (3.9-9.2)	5.5 (3.5-7.7)
Number Concentration (x10⁵/cm³)	2.0 (1.8-2.5)	1.8 (1.5-2.5)	1.6 (1.2-1.9)	0.72 (0.42-1.1)	0.61 (0.35-0.98)	0.49 (0.30-0.59)
Data Source: Zhu 2002a, 2002b. Range given in parenthesis.						

Zhu (2002b) also compared the size-resolved number concentrations of ultrafine particles measured 30 meters from I-710 and I-405 freeways. Note that both freeways have nearly the same average traffic density; however, I-710 traffic emits higher levels of PM due to the greater proportion of heavy duty diesel trucks. Both sets of measurements showed three distinct modes. The number concentration close to I-405 for the first mode (10 and 20nm) is slightly higher than corresponding measurement at I-710. However, the concentration for the second mode (around 30 nm) is nearly 30% higher for the I-710 site than that of the I-405 site and is attributed to higher levels of BC particles emitted by diesel vehicles on I-710. The concentration of the last mode (around 70 nm) is similar in both studies and close to the background concentrations.

As discussed in the previous section, meteorological parameters such as temperature and relative humidity play a major role in the processing of ultrafine particles. A comparison of summer and wintertime monitoring data for the I-405 and I-710 sampling sites showed that ultrafine number concentrations in winter are higher than in summer for comparable level of traffic densities. In addition, the decay rates of ultrafine particles, CO, and BC are slightly smaller than those in summer. This decrease in the dilution rate is attributed to the prevailing lower wind speeds during winter. When the size-segregated data was compared, the mode with the smallest diameter (10 to 20 nm) persisted for longer distance during the winter season.

More recent studies have employed mobile measurement platforms to conduct more comprehensive data collection. As opposed to the studies that use a limited number of fixed monitoring locations, mobile platforms measure concentration at all directions from the road from a parallel to perpendicular direction along the roadway, but for generally shorter durations. Further, mobile measurements often also include video and audio recordings of the surroundings in order to infer possible pollution with specific sources, such as passing or following a diesel truck.

Kozawa et al. (Kozawa, Fruin et al. 2009) used an electric vehicle as a mobile measurement platform and collected measurements on two routes of about 30 miles each covering arterial roads in residential areas and freeways in the cities of Carson, San Pedro, Wilmington, and West Long Beach. Among other instruments to measure gas-phase species, the mobile platform also included a portable CPC (TSI Portable CPC, Model 3007) and FMPS (Model 3091, TSI), both having a time resolution of 10 seconds. The CPC was used to measure number concentration of particles in the range 10 nm to 1 µm and the FMPS to provide the size distribution and particles in the range of 5.6 to 560 nm.

Measurements in the Kozawa et al. study were collected by driving twice a day along the two routes, once in the morning between 8:00 and 10:30 AM and again in the afternoon between 14:30 and 17:00, two to three times per week in the summer and winter of 2007 covering a total of 24 sampling days. Since the goal of the study was to measure representative ambient concentrations, individual vehicle influences, such as a passing or trailing a high emitting diesel truck, were removed from the assessment based on the analysis of video recordings made during the measurements. Measured concentrations were analyzed using the “impact zone” and “reference zone” designations based on the location of the measurement and then calculating the ratio of concentration within the impact zone with that of the reference zone. Any location within 150 meters from a major roadway is designated to be within the impact zone. All other locations more than 150 meters from a major roadway are said to be in the reference zone. In addition, meteorological data from the South Coast Air Quality Management District (SCAQMD) monitoring station at North Long Beach were used to determine if the measurement locations are at a downwind or upwind of a major roadway.

Using the above approach, Kozawa et al. observed that the ratio of ultrafine number concentrations in the impact zone to the reference zone in the I-710 area to be at least 2 and as high as 3.7 times higher in the morning hours, and when the impact zone is downwind of the freeway. The impact- to reference-zone ratios were approximately 1 (or no change) when the impact zone was upwind of the freeway.

Near-roadway studies, such as those discussed above, often compare pollutant concentrations close to the freeway with those of “background” or reference concentrations. Background concentration is typically measured more than 300 meters downwind or upwind of the freeway. For community-scale exposure and impact assessments, the variation in the background concentration also becomes important, especially in order to devise air quality improvement strategies. Insights on neighborhood-scale variation of ultrafine particles, especially in communities that are in the vicinity of the major transportation routes, will provide insight as to whether to focus air quality improvement strategies on a broader or local/neighborhood scale.

Moore et al. (Moore, Krudysz et al. 2009) measured ambient ultrafine particles using a network of 14 closely-spaced monitoring sites that were set up in the Los Angeles area as two clusters—San Pedro/Wilmington and West Long Beach. At these sites, total number concentration of particles greater than 7 nm is measured using a CPC (3022A, TSI Inc.). The measurements were taken from February through December of 2007 in order to assess intra-community variability in the ambient ultrafine particle concentrations. A number of sites within the West Long Beach cluster are in the proximity of I-710 at varying distances. This study showed that the total particle number can vary up to a factor of 10 for sites within a few kilometers. Although the proximity to roadways was a major factor in the variability, the observations emphasize that urban areas have elevated concentrations relative to background levels and that ultrafine concentrations vary widely between communities due to proximity to roadway sources as well as other sources of ultrafine particles.

4.1. Exposure to Ultrafine Particles in Los Angeles Area

Human exposure may generally be defined as any event where a person comes in contact with a contaminant of concern. During an exposure event, the contaminant may enter the human body through one of the exposure pathways (or exposure routes). The main exposure pathways are inhalation, ingestion, and dermal absorption. Exposure to ultrafine particles predominantly occurs through the inhalation of polluted air.

People are exposed to ultrafine particles during the course of their daily activities depending on various microenvironments they spend time in, the amount of time spent, and the concentration of ultrafine particles in those microenvironments. A microenvironment is any space in which human contact with an environmental pollutant takes place and which can be treated as a well-characterized, relatively homogeneous location with respect to pollutant concentrations for a specified time period. Microenvironments are generally grouped into three categories: outdoor, indoor, and in-vehicle. For example, parks, outdoor recreation spaces, and near-roadway locations are some common outdoor microenvironments; residences, schools, and offices are some common indoor microenvironments; and cars, public transit vehicles, and air travel compartments are some common in-vehicle microenvironments.

In the context of near-roadway environment, two classes of populations that are most vulnerable to ultrafine particles exposure: 1) residents or occupants of non-residential buildings within in the vicinity of major roadways, and 2) drivers and passengers of on-road vehicles. The extent of exposure within these two microenvironments (home/office and in-vehicle) mainly depends on the air exchange rate that determines the extent of penetration of outdoor contaminated air into the microenvironment. Air exchange rates are governed by several factors such as ventilation and meteorological factors (wind speed).

Although exposure to gas-phase pollutants in a near-roadway environment is still a major research area, exposure specifically to ultrafine particles is gaining attention. A recent review published by Knibbs et al. (Knibbs, Cole-Hunter et al. 2011) identified 47 studies that reported numerical exposure values to ultrafine particles across various transportation modes. Based on this data, the trip-weighted mean ultrafine particle concentration near automobile tunnels was highest at 300,000 particles/cm^3 and that in a non-tunnel automobile trip was 45,100 particles/cm^3. By way of comparison with some typical indoor activities, Wilson et al (Wilson, A., O. Karpukhin, L. DeLaura, 2010) found that indoor concentrations of ultrafines during cooking meat, burning candles, and vacuuming ranged between 150,000 to 200,000 particles/cm^3.

In a recent study done by USC researchers (Hudda, Cheung, Moore, and Sioutas 2010), they found that the 2009 outdoor concentration at the University of Southern California site, which was located in an area believed to be representative of a typical urban background site, the highest ultrafine particle concentration occurred in January with an average concentration of 30,000 particles/cm^3 and the lowest ultrafine particle concentration of around 10,000 particles/cm^3 occurred during September. This is comparable to the background concentrations measured by Zhu et al. (2002a), which reported a background concentration of 30,000 particles/cm^3 at 300 meters, but the Zhu study was done in 2001 and ultrafine particle concentrations have shown a region-wide decrease across the South Coast region over this time period.

Two of the recently published studies on exposure to ultrafine particles in near-roadway environment in the LA basin are discussed here. Zhu, et al. 2005 concurrently measured ultrafine particle concentrations for four two-bedroom apartments located within 60 meters of the I-405 freeway. Three of these apartments are located on eastern side of the I-405 on the third floor. The fourth apartment is located on the western side of the I-405 on the second floor. All four apartments are within 50 meters of each other. Measurements were collected under three infiltration conditions: infiltration, mechanical ventilation, and with an open window. Size-segregated number concentration of ultrafine particles were measured using SMPS (3936, TSI Inc.) between October and January of 2003. Total particle number concentration was also measured independently using a particle counters (Model 8525, TSI Inc.) with a lower cut size of 20 nm. The penetration of ultrafine particles into residences is quantified using the ratio of Indoor to Outdoor (I/O) number concentrations of ultrafine particles. The I/O ratios are highest—close to 1.0—across all particle size ranges when the windows are open. Under the infiltration (natural ventilation) condition, the highest ratios (0.6 to 0.9) were observed for larger particles in the size range of 70 to 100 nm, while the lowest I/O ratios (0.1 to 0.4) occurred for particles in the size range of 10 to 20 nm. Finally, the lowest I/O ratios (0.2 to 0.6) occurred when the fan was on (mechanical ventilation) and is attributed partial filtering by the air-handling system in these apartments. The generally high I/O ratios indicate that residents in the vicinity of freeways are potentially exposed to ultrafine particles at levels similar to those in the outdoor air. Similar exposures would be anticipated along I-710 in close proximity and at the same elevation level as the roadway.

In addition to the exposure in indoor environments, in-vehicle exposure while driving on heavily-trafficked freeways is also shown to be significant. Zhu, et al. (2008) measured outdoor and in-vehicle particle number concentrations for three different vehicles (Volkswagen Jetta, Audi A4, and PT Cruiser) while driving on I-405 and I-710 in the LA area. Measurements were taken under three different air circulation conditions: 1) circulation fan off and recirculation off; 2) fan on and recirculation off; and 3) fan on and recirculation on. It is expected that outside air enters the vehicle only in conditions 1 and 2.

Results showed that the particle concentrations inside the vehicle closely tracked outside concentrations under conditions 1 and 2. I-710, with a high proportion of trucks and therefore a large number of ultrafine particle emissions, resulted in the highest in-vehicle ultrafine particle concentrations and therefore the highest exposure as well. The penetration ratio (ratio of indoor to outdoor particle concentrations) was highest when both the fan and recirculation are off and varied between 0.3 and 0.5. These ratios are similar for both the freeways. Overall, maximum protection was obtained when both the fan and recirculation were on. Further, based on the observations from this study, the authors concluded that the exposure to ultrafine particles from a 1-hour commute on busy LA freeways is equivalent to 10 hours of exposure in urban backgrounds away from a freeway.

5. Current and Prospects of Future Regulations on Ultrafine Particles

There are potentially two direct ways of regulating ultrafine particles: 1) by setting ambient standards, similar to that of PM mass per unit volume and other gas-phase pollutant standards, and 2) by regulating the tailpipe emissions, i.e., source-based regulation. Indirect ways of regulating ultrafine particles include restrictions on fuel composition.

Currently, there is no ambient air quality standard any place in the world that regulates the number concentration of airborne particles.

Until recently, there were no emission standards that regulated the particle number concentration from vehicle tailpipes. However, in July 2008, the UK Department of Transportation proposed an emissions standard for light and heavy duty compression (diesel) ignition vehicles at 6×10^{11} particles/km. These limits were agreed for inclusion in the European tailpipe standards for Euro-5 and Euro-6 emission standards. Euro-5 tailpipe particle number standards are being phased in starting in September 2011 and fully phased for all models by January 1, 2013. The test methodologies for the implementation of this standard were developed under the Particulate Measurement Program (PMP) of United Nations Economic Commission for Europe (UNECE). PMP, initiated in 2001, is an inter-governmental research program to develop new vehicle exhaust measurement protocols for regulatory applications. The PMP focuses on development of methodologies to measure solid particles in the range 23 to 2500 nm. Per the PMP test procedure, only solid particles are counted towards the emission standard since any volatile material is removed from the sample. The US Environmental Protection Agency (EPA) has reviewed the PMP testing method and does not see this as an acceptable approach for the US partly because of the missing volatile material.

The EPA has no immediate plans to regulate ultrafine particles. However, there is increasing interest within the EPA in researching investments directed towards the understanding of ultrafine particles and their significance relative to fine particles (PM2.5) and their role in causing adverse health effects. To address these questions, the EPA's priority research goals include investigating ultrafine exposures and the role of different PM size fractions in health outcomes; exploring the potential for alternatives to the current PM mass-based standards; and examining the exposure and health effects of ultrafine components.

In California, the California Air Resources Board (CARB) has authority to set its own standards through an exemption granted under the Clean Air Act if granted by EPA. Recently, CARB has indicated that regulatory actions may be forthcoming to reduce mass and particle number from engines under the LEV III standards. Specifically, they have proposed an optional PM emission standard beginning in 2014 for super ultra low emission light-duty gasoline vehicles (SULEV) to have a solid particle number less than 6×10^{12} particles per mile, approximately equivalent to the European Union (EU) standard. This would allow vehicles to be certified for the EU standard and sold in CA without certification to the CARB PM emission standard. However, CARB has received feedback on several issues regarding testing procedures for this optional standard and may not include in its final recommendation to the state board due in December 2011. They anticipate now to continue pursuing a particle based standard once they have addressed concerns over testing procedures for the standard. At this time there are no plans for regulating heavy-duty diesel engines as diesel particulate filters appear to be the only lowest achievable technology for reducing DPM emissions and this is the current technology being used in all new diesel engines. CARB will continue to look at issues on how to measure emissions of semi-volatile and volatile ultrafine particles. Technical staff from CARB will publish their final recommendations for California's LEV-III standards to the Air Resources Board in late October 2011.

Local agencies, such as SCAQMD, can also take steps to mitigate ultrafine particle pollution. These can be mainly through mandating requirements on the transportation fleet and also the design of the transportation infrastructure itself. As discussed earlier, heavy-duty engines emit a higher number of particles in high acceleration and low-speed scenarios. Therefore, measures to alleviate congestion and thus promote free-flow of traffic may lead to a reduction in ambient ultrafine particles.

Recently, SCAQMD has announced plans for a new focus under their Multiple Air Toxic Exposure Study (MATES) program – MATES-IV. This study will include looking at measuring ultrafine particles as well as diesel PM near freeways, arterials, intersections, warehouse areas, rail lines, rail yards, and airports. The MATES-IV will examine ultrafine particles from both mobile platforms and fixed locations. Work plan and protocol development began this summer with advisory group meetings starting this fall and board approval by the end of the year. Monitoring for MATES-IV is planned to start in June 2012 and will continue for 1 year. It will be decided in the planning process if and how SCAQMD would conduct modeling of ultrafine particles.

At least one study, Hussein et al (2007), has attempted to model the near-roadway ultrafine particle number. The modeling exercised in the study used both a dispersion model to simulate the transport and turbulent mixing from the roadway to downwind locations and an aerosol dynamic model to simulate particle number size distribution. Two winter periods were simulated in Helsinki, Finland. Even though the model used a very low mixing volume, the model underpredicted concentrations 65 meters downwind by about a factor of 3. This underprediciton was attributed to uncertainty in the emission factors for the ultrafines and the lack of specificity of those emissions factors under varying ambient conditions (e.g., temperature and relative humidity).

In addition to modeling of ultrafine particles, recent efforts have focused on the development of emission inventories for ultrafine particles (Keogh and Sonntag 2011). In this study, the authors developed what they believe is the first published emission inventory of ultrafine particles generated by on-road mobile sources. This emissions inventory was prepared for urban Southeast-Queensland, covering 46,000 square kilometers, which includes all of the Brisbane metropolitan area. The inventory quantified both ultrafine particles (particle number) and particle mass emissions for the motor vehicle fleet, which included light and heavy duty vehicles and buses. The inventory covers a full size range of particles emitted by motor vehicles, and quantified emission rates for different vehicle types and road links. Average particle number and particle mass emission factors were derived using statistical analysis of more than 600 emission factors as identified in the published literature and combined with travel demand model data for the study region relating to 22,985 model links representing roads in the study region. The average particle number was considered suitable for use in other developed countries for quantifying particle inventories. This assumption is based on the finding in the statistical analysis that relatively few statistically significant differences were found between the mean values of published emission factors for different particle metrics for different countries of study and study location (measured on a dynamometer, in a tunnel, or in the vicinity of a road). Results from the study showed that for Brisbane, the annual emissions from on-road mobile sources was in aggregate about the same as annual particle number emissions due to artifact operations from Brisbane International Airport. The ultrafine inventory also revealed that while heavy-duty diesel vehicles only contributed 6% of the vehicle miles traveled, they accounted for more than half of the region's ultrafine particles.

6. Summary

Following are some major conclusions based on the current understanding of ultrafine particles.

- Studies have shown that ultrafine particles are at significantly elevated levels in near-roadway environments. These particles, which constitute most of the particle count in the ambient PM, have been linked to adverse health effects.
- Meteorological conditions have a significant effect on the distribution of ultrafine particles from roadways; the highest exposure to populations in the prevailing downwind direction.
- Although there have been major advances in the development of instrumentation to characterize ambient ultrafine particles, especially their number concentration, some challenges still remain. These mainly include the lack of standardized protocols which are essential for monitoring and developing regulations on ultrafine particles.
- Heavy-duty diesel trucks are the largest emitters of ultrafine particles among all vehicle classes. However, currently there are large uncertainties in relation to vehicle emission factors of ultrafine particles. This is partly due to the variability of emissions based on the fuel-type, fuel composition, and engine load and control technologies/after treatment devices.
- Measurement studies have shown that ultrafine particles are at significantly elevated levels in the vicinity of I-710. These high concentrations drop exponentially with the distance from the freeway and reach urban background levels at around 300 meters.
- Studies have shown that ultrafine particles can penetrate efficiently into indoor environments. Therefore, people living and working in the vicinity of major highways are exposed to high levels of ultrafine particles. Furthermore, in-vehicle exposure while driving on highways is also shown to be significant.
- Currently there are no immediate plans to directly regulate ambient levels. However, CARB has proposed a solid particle number standard for tailpipe emissions for SULEVs starting in 2014.

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Physical properties of particulate matter (PM) from late model heavy-duty diesel vehicles operating with advanced PM and NO_x emission control technologies

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ABSTRACT

Emission control technologies designed to meet the 2007 and 2010 emission standards for heavy-duty diesel vehicles (HDDV) remove effectively the non-volatile fraction of particles, but are comparatively less efficient at controlling the semi-volatile components. A collaborative study between the California Air Resources Board (CARB) and the University of Southern California was initiated to investigate the physicochemical and toxicological characteristics of the semi-volatile and non-volatile particulate matter (PM) fractions from HDDV emissions. This paper reports the physical properties, including size distribution, volatility (in terms of number and mass), surface diameter, and agglomeration of particles emitted from HDDV retrofitted with advanced emission control devices. Four vehicles in combination with six after-treatment devices (V-SCRT®, Z-SCRT®, CRT®, DPX, Hybrid-CCRT®, EPF) were tested under three driving cycles: steady state (cruise), transient (urban dynamometer driving schedule, UDDS), and idle. An HDDV without any control device is served as the baseline vehicle.

Substantial reduction of PM mass emissions (>90%) was accomplished for the HDDV operating with advanced emission control technologies. This reduction was not observed for particle number concentrations under cruise conditions, with the exceptions of the Hybrid-CCRT® and EPF vehicles, which were efficient in controlling both—mass and number emissions. In general, significant nucleation mode particles (<50 nm) were formed during cruise cycles in comparison with the UDDS cycles, which emit higher PM mass in the accumulation mode. The nucleation mode particles (<50 nm) were mainly internally mixed, and evaporated considerably between 150 and 230 °C. Compared to the baseline vehicle, particles from vehicles with controls (except of the Hybrid-CCRT®) had a higher mass specific surface area.

1. Introduction

Recent *in vitro* and *in vivo* animal studies suggest that ultrafine particles (for this study particles <180 nm) may be more toxic than both $PM_{2.5}$ and PM_{10} (Li et al., 2003; Oberdorster, 2000). The most prominent sources of ultrafine particles in an urban metropolis like Los Angeles are vehicular emissions and secondary photochemical reactions (Fine et al., 2004; Zhang et al., 2004). Heavy-duty diesel trucks constitute only a small fraction of the total fleet in California but have an important contribution to the emissions of fine and ultrafine particles. Diesel

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exhaust particles (DEP) are normally agglomerates of hundreds of volatile/semi-volatile species adsorbed onto its refractory carbonaceous core (Bayona et al., 1988). Some of these constituents are known carcinogens (Stayner et al., 1998; Solomon and Balmes, 2003). Also DEP are capable of inducing systemic inflammation by imparting oxidative stress in susceptible cells (Koike et al., 2002; Shima et al., 2006) and are instrumental in causing asthma symptoms and may contribute to cardiopulmonary diseases (McClellan, 1987; Dockery et al., 1993, Nel et al., 2001).

As general perception has emerged towards the potential risks of diesel particulate matter (PM), policy makers are promulgating stricter emission control rules and regulations. The US EPA 2007 emissions standard reduces the diesel PM mass emission from heavy-duty engines ten fold from the old 0.1 g $bhp^{-1} h^{-1}$ PM limit to 0.01 g $bhp^{-1} h^{-1}$ (Merrion, 2003). To effectively meet such stringent emission standards, various advanced engine design and control technologies are being considered and rigorously evaluated for the newer fleet of heavy-duty trucks. While these after-treatment devices (such as diesel particulate filters (DPF)) have been highly efficient in removing refractory solid particles (>50 nm), some of the potentially harmful volatile and semi-volatile species (such as PAHs), originally emitted in the vapor phase at high plume temperature, may penetrate through (Kittelson et al., 2006; Matter et al., 1999a). As the exhaust temperature decreases drastically at the tail pipe exit, these vapor phase species condense and form fresh nucleation mode particles. (Kittelson, 1998).

Various on-road as well as dynamometer experiments have shown that these particles are predominantly externally mixed (except particles <20 nm). The volatile fraction roughly contributes 10–30% of the total mass and 70–90% of particles by number (Sakurai et al., 2003). Particle volatility is strongly dependent on gas to particle phase partitioning and is extremely sensitive to dilution and temperature conditions (Liu et al., 2007a; Abdul-Khalek et al., 1999; Wei et al., 2001a, b; Kuhn et al., 2005, Biswas et al., 2007). Zhang and Wexler (2004) showed that condensation, evaporation and dilution are the three major factors affecting the evolution of size distribution near a freeway. Thus, particle volatility plays key roles in shaping the particle size spectrum and eventually determining the level of human exposure to different aerosol components (volatile or non-volatile) originating form traffic emissions.

In addition to volatility, particle surface characteristics are important physical parameters in determining PM toxicity. Some researchers have argued that particle surface area is a better metric to predict health endpoints than particle mass or number and should be included as an essential element while considering new regulatory tools (Maynard, 2006; Oberdörster et al., 2005; Nygaard et al., 2004). This is because the availability of reaction sites to cause cell damage is more likely to be directly proportional to surface area available to lungs (Maynard, 2006). Surface properties will also be relevant in future as the control technologies are reported to generate considerable number of small particles (Bagley et al., 1998; Geller et al., 2005) leading to a net increase in surface area per unit mass of PM.

The primary objective of this collaborative study between the California Air Resources Board (CARB) and the University of Southern California is to estimate physicochemical and toxicological characteristics of the volatile and non-volatile fractions of particles emitted from a variety of different engines, fuels and emissions control, each operating under different driving conditions using a dynamometer setup. In this paper, we will focus only on the physical PM properties, i.e. size distribution, volatility and surface characteristics for diesel vehicles retrofitted with state-of-the-art after-treatment devices. Comparisons within HD vehicle types and driving cycles and also with respect to a baseline vehicle (without any control technology) will be discussed. Details of PM chemical and toxicological characteristics from these vehicles will follow in subsequent publications.

2. Methods

Experiments were carried out at the CARB's heavy-duty diesel emission testing laboratory (HDETL) in downtown Los Angeles. Ayala et al. (2002) described the dynamometer specifications in details. Fig. 1 shows the schematic of the experimental setup. The sampling train includes heavy-duty chassis dynamometer, constant volume sampling (CVS) dilution tunnel and aerosol samplers. Diesel vehicle exhausts were transported by a stainless steel hosepipe and diluted with filtered air through the CVS. Measurements were taken 18 diameter lengths downstream of the exhaust introduction in the CVS. Three driving cycles, i.e. steady state cruise (50 mph), transient (EPA urban dynamometer driving schedule (UDDS)) and idle were tested to simulate various real-world driving conditions. The fuel used to run the engines was CARB ultra-low sulfur diesel (ULSD) with sulfur content <15 ppm. Tunnel blank levels were measured and vehicles were conditioned (warmed up) everyday before the start of official runs. The CVS was cleaned before starting the project.

2.1. Vehicles

The test fleet comprised of four heavy-duty diesel vehicles (HDDV) in seven configurations (Table 1). A 1998 Kenworth truck was served as a baseline vehicle, without any emission control technology. The same Kenworth truck was also tested with three different control technologies: a continuously regenerating technology (CRT®), consisting of a diesel oxidation catalyst (DOC) followed by an uncatalyzed trap; CRT® in combination with a selective catalytic reduction system (Zeolite- or vanadium-based SCRT®s). The SCRT systems used for this study were prototype systems and not yet ready for full-scale production. The other three test vehicles were a diesel hybrid electric bus, a school bus, and a Caltrans truck.

The two SCRT® technologies consist of a wall-flow particulate trap (CRT) followed by an SCR section. The

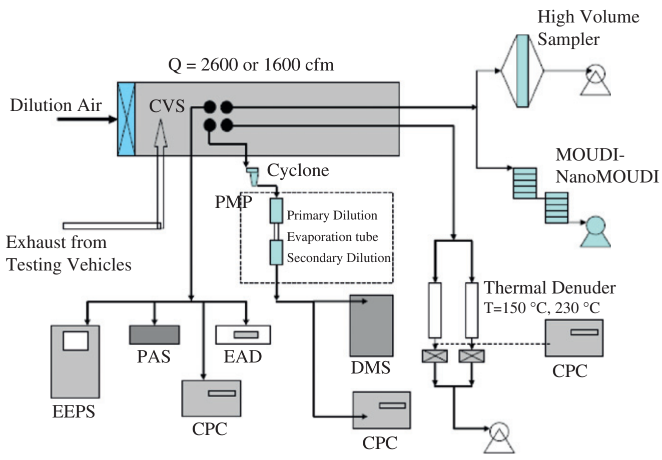

Fig. 1. Experimental setup.

CRT® was the same in each configuration. The difference between them lies in the choice of catalysts (vanadium or Zeolite) for the SCR to control oxides of nitrogen (NO_x). The Caltrans truck, with a smaller engine (7.6 L) than the Kenworth truck (11 L, Table 1), is retrofitted with an Engelhard DPX® filter. The DPX® filter is comprised of a diesel particulate trap with a catalytic wash-coat. The diesel hybrid electric bus (San Joaquin Valley RTD) is equipped with a catalyzed continuously regenerative trap, or CCRT®, consisting of a DOC followed by a catalyzed trap, which was virtually brand-new, with only 1000 miles on the odometer. The last test vehicle was an Elk Grove school bus, equipped with an electric particle filter (EPF). The EPF consists of a non-catalyzed silicon carbide substrate for PM control, coupled with an electric heating element and a small blower. The trap is regenerated periodically using electricity from the grid (plug in configuration) during non-operational periods—mostly at night. Hereafter, the test fleet is referred as baseline, CRT®, V-SCRT®, Z-SCRT®, DPX®, Hybrid-CCRT® and EPF.

The dilution air flow rate at CVS was 2600 cfm ($74\,m^3\,min^{-1}$) for cruise and UDDS cycles, and 1600 cfm ($45.4\,m^3\,min^{-1}$) for the idle. For EPF and Hybrid-CCRT®, the flow rates were maintained at 1600 cfm for all cycles. These flow rates result in approximate dilution ratios of 6–9 for cruise, 5–80 for UDDS, and 15–25 for idle.

2.2. Equipment and instruments

Specific descriptions of some of the instruments and equipment used for this study are provided in this section.

2.2.1. Nano-MOUDI

Size-resolved samples were collected using a micro-orifice uniform deposited impactor (MOUDI) upstream of a nano-MOUDI (MSP Corporation, Minneapolis, MN, USA) loaded with pre-cleaned aluminum foil substrates. Particles were classified in the following aerodynamic size ranges: 10–18 nm, 18–32 nm, 32–56 nm, 56–100 nm, 100–180 nm, 180 nm–2.5 μm, and >2.5 μm. The MOUDI-Nano MOUDI tandem was operated for multiple runs in order to accumulate sufficient mass for chemical analysis for each vehicle and driving cycle.

2.2.2. DMS/EEPS

Size distribution of engine exhausts from the CVS was monitored every second by two multiple channel differential mobility spectrometers: a DMS500 (Cambustion) and an engine exhaust particle sizer (EEPS 3090, TSI Inc.). Both DMS and EEPS classify particles on the basis of their mobility diameter. The cut-off size ranges of EEPS and DMS are 5.6–523 nm and 4.5–1000 nm, respectively. With high-time resolutions, they are both capable of tracking transient particle behavior, especially during UDDS cycles. With few exceptions (V-SCRT, Z-SCRT only), in which the DMS was placed downstream of the particle measurement program (PMP) sampler, both instruments were connected directly to CVS.

2.2.3. PMP

A PMP protocol was developed in Europe to measure the solid particle emissions from light-duty vehicles. The sampling train of PMP contains a volatile particle remover (VPR) and a particle counter. The VPR provides two stage dilution connected by an evaporation tube (ET). The temperature for the primary dilution, ET and secondary dilution is 150, 300, and ~35 °C, respectively. Detailed information for the PMP can be seen in Herner et al. (2007a).

2.2.4. Thermodenuder

Particle volatility was determined by two thermodenuders (Model ELA-230, Dekati Ltd.) sampling in parallel, each heating the entering aerosol to 150 and 230 °C, respectively. The thermodenuder consists of a heating section, followed by an adsorption/cooling unit. As aerosol stream was drawn from the CVS and passed through the heating tube, part of its volatile/semi-volatile components was sheared off. These labile species adsorb onto a layer of activated charcoal placed on the walls of the thermodenuder, leaving the non-volatile PM fraction to be collected on Teflon filters (47 mm, PTFE, Gelman) placed downstream of the thermodenuders. Multiple runs were

Table 1
Details of test fleet

Vehicle							Engine		After treatment (AT)		Dilution (approximate dilution ratio in CVS)
Make	Nomenclature	Year	Miles	Curb weight (lb)	GVWR (lb)	Tested weight (lb)	Model	Size (L)	Type	Miles on AT	
Kenworth	V-SCRT®	1998	360,000	26,640	80,000	53,320	Cummins M11, reflashed	11	Vanadium-based SCRT®	50,000	9.2 cruise 6–30 UDDS 14 idle
Kenworth	Z-SCRT®	1998	360,000	26,640	80,000	53,320	Cummins M11, reflashed	11	Zeolite-based SCRT®	0 on SCR, 50,000 on CRT	9.2 cruise 6–30 UDDS 14 idle
International	DPX®	1999	40,000	15,030	27,500	20,920		International DT466E	7.6	Engelhard DPX	30,000
6.2 cruise 5–25 UDDS 22 idle											
Gillig (35 ft) with Alison hybrid	Hybrid-CCRT®	2007	1000	NA	NA	NA	Cummins	5.9	CCRT®	1000	5–50 UDDS
Thompson-school bus	EPF	1988	325,000	NA	NA	NA	Cummins	5.9	Cleaire-Horizon	32,000	8.3 cruise 8–80 UDDS 25 idle
Kenworth	CRT®	1998	NA	26,640	80,000	53,320	Cummins M11, reflashed	11	Continuously regenerating technology	64,000	9.2 cruise 6–30 UDDS 14 idle
Kenworth	Baseline	1998	374,000	26,640	80,000	53,320	Cummins M11, reflashed	11	None	NA	9.2 cruise 6–30 UDDS 14 idle

integrated to achieve desired sample mass loadings on these filters to perform various chemical and toxicological analyses. Solid particle number concentrations and size distributions were monitored intermittently by a condensation particle counter (CPC 3022 A, TSI Inc., MN) and a differential mobility particle sizer (DMA, TSI 3085).

2.2.5. Electrical aerosol detector (EAD)

Several instruments are currently in use to assess PM surface related properties. In this study, a diffusion charger, the TSI EAD 3070A, was used to characterize the transient as well as steady state behavior of aerosols. The EAD consists of a unipolar diffusion charger and an electrometer. Particles are charged by diffusion and then drawn through the electrometer which records total current (I) carried by the aerosol stream. Studies have shown that the response of EAD is a function of $D_p^{1.13-1.16}$ (Woo et al., 2001; Jung and Kittelson, 2005; Wilson et al., 2007). This response is particularly an useful PM metric because it corresponds to the actual particle surface area exposed to the environment and can be used to quantify, for example, the area available for adsorption of gaseous species or for interaction with the epithelial tissue in the lungs (Wilson et al., 2007). Because the EAD signal is closely related to aerosol diameter (Jung and Kittelson, 2005) the manufacturer has marketed this instrument to indicate total aerosol length in mm cm^{-3}.

2.3. Data reduction

The physical properties of aerosols from the various vehicles and driving cycles were reduced to three variables, originally introduced by Ntziachristos and Samaras (2006) intended to serve as means to discriminate the effects of fuel, driving condition and vehicle control technology on particle emissions in dynamometer studies. These variables are as follows:

- *Reduced variable 1*: volatility ratio

$$R = \frac{N_{\mathrm{Exhaust}}}{N_{\mathrm{TD}}}, \tag{1}$$

where N_{Exhaust} is the total dilution corrected DMS or EEPS number concentration at the CVS ($D_p \geqslant 7$ nm), N_{TD} the number concentration measured by CPC after the thermodenuders ($D_p \geqslant 7$ nm).
This is a measure of particle volatility in terms of number concentration.

- *Reduced variable 2*: surface-rated diameter
The EAD electrometer current is given by (Woo et al., 2001)

$$I = N_p N_t e Q, \tag{2}$$

where I is the total current measured by EAD (fA); N_p the charge (charge particle^{-1}) attachment, $0.0181 D_s^{1.13}$ (Jung and Kittelson, 2005); D_s the surface-rated diameter (nm); e the elementary charge, 1.6×10^{-19} C; Q the aerosol flow rate through EAD, 1.5 lpm (1.5 lpm aerosol, 1 lpm sheath flow); N_t the total exhaust particle number, 10–1000 nm from DMS, 10–523 nm for EEPS.
Note: particle number in the 523–1000 nm range is insignificant.
Now substituting in Eq. (2)

$$D_s = \left(\frac{I}{0.0181 N_t e Q}\right)^{1/1.13}. \tag{3}$$

- *Reduced variable 3*: mass specific surface area

$$A = \frac{S}{\mathrm{PM}}, \tag{4}$$

where A is the mass specific surface area (m^2 g^{-1}), S the surface concentration, m^2 km^{-1}. For the calculation of A, the EAD current was converted to particle surface area using the conversion factor of 65 μm^2 pA^{-1} ($R^2 = 0.9$, alveolar deposition) reported by Wilson et al. (2007). PM is the total particle mass collected between 10 nm and 2.5 μm nano-MOUDI stages, mg km^{-1}.
The nano-MOUDI substrate mass ($\leqslant$2.5 μm) measurements were in excellent agreement with parallel CARB reference filter measurements ($R^2 = 0.99$; slope = 0.95, intercept = 2.4 mg km^{-1}) and used to calculate mass-based parameters. Filter mass was used only for V-SCRT-Cruise (nano-Moudi data not available).
It is a measure of particle agglomeration. Particle agglomeration increases with decreasing A.

3. Results and discussion

3.1. Size distribution

Fig. 2 presents tunnel blank-subtracted mean size distributions for vehicles at different operating conditions. These distributions derived from DMS/EEPS measurements are grand averages of multiple runs for each driving cycle. The data are reported in terms of number per vehicle kilometer traveled for cruise and UDDS cycles, and number per hour for idle. The primary focus here is to give a brief overview in order to provide meaningful insights and support to some of the findings described in subsequent sections.

While performing preliminary quality assurance–quality control (QA/QC) of real time data for SCRT®s (V-Cruise, UDDS, Z-Cruise), we noticed that few EEPS sizes channels (10–20 nm) were almost always saturated due to particle over-loadings. These size bins were subsequently replaced with corresponding secondary dilution-corrected DMS data (the DMS was placed downstream of the PMP secondary dilution with the ET off) to obtain more accurate size distributions. For rest of the test fleet (except CRT®), we used data from the DMS, which was directly connected to the CVS. We have added a tunnel blank distribution in Fig. 2f (baseline vehicle).

Size distribution patterns for both SCRT®s are quite similar with sharp modes (Fig. 2a, b) at ~10 nm. The distinguishable feature is the less prominent nucleation mode for UDDS runs especially for the Z-SCRT-UDDS cycle. This may be due to the fact that the Zeolite-SCRT requires

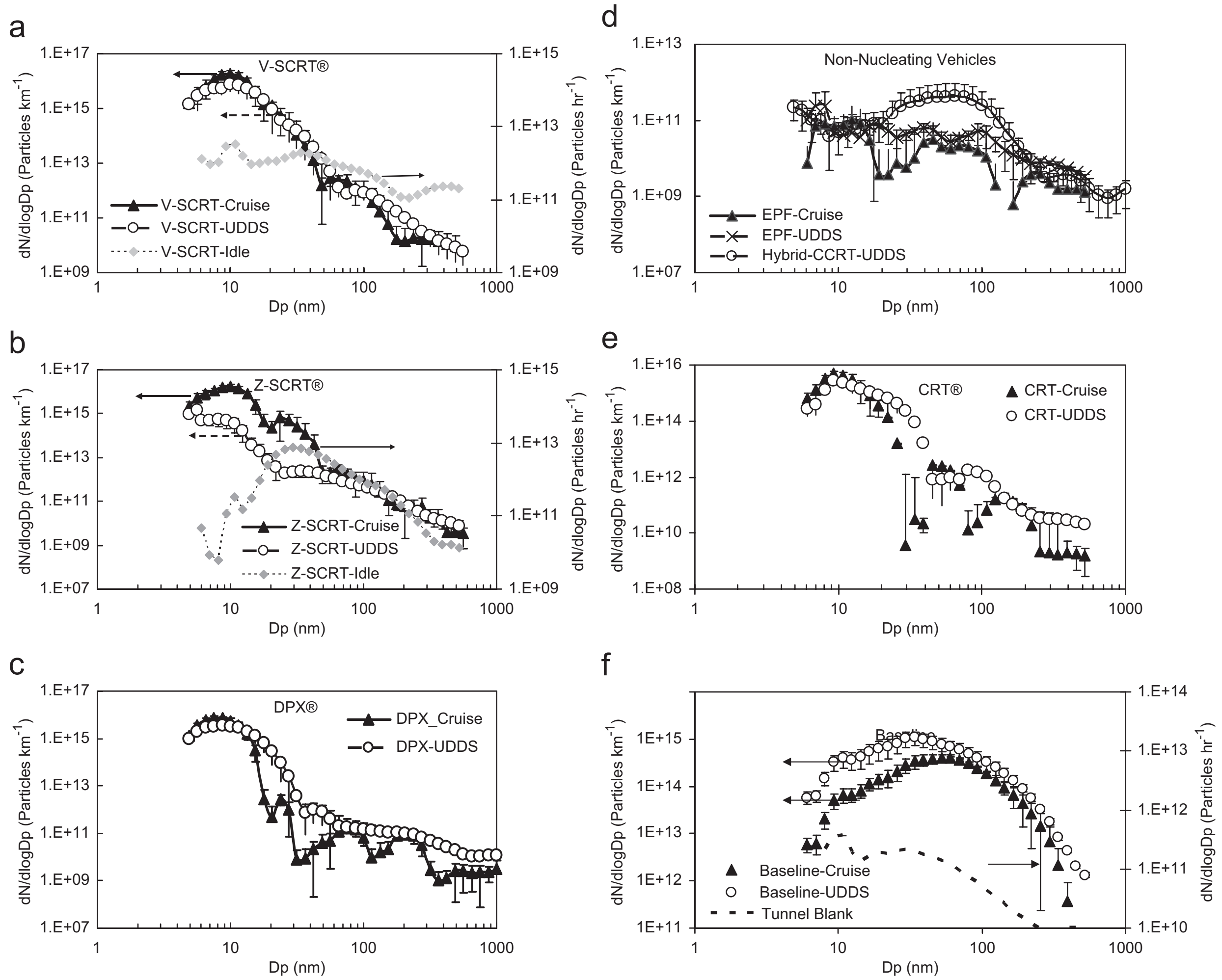

Fig. 2. Particle number size distribution.

much higher temperature to trigger and sustain nucleation than the vanadium-based SCRT catalysts (Herner et al., 2007b). Moreover, in general the zeolite catalysts have lot more catalytic surface area than vanadium catalysts and the Z-SCRT system used for this study is completely new (Table 1). These provide higher storage sites for sulfate generated by the upstream DOC and DPF during transient and low-temperature testing.

Although the main purpose of SCR® technologies is to reduce NO_x by ammonia, at elevated temperatures, their in-built catalysts may encourage the formation of sulfate, an important component acting potentially as seed aerosol for particle formation by condensation of semi-volatile organic vapors, as explained earlier. Chemical data collected will be used to determine composition and will be reported in future publications. For a brief sampling period, we bypassed the SCR portion from exhaust after-treatment system (SCRT®) just to investigate the impact of the SCR catalysts. Although, this modification did not result in visible alteration of the shape (on log scale) of the distributions (CRT®, Fig. 2e), number concentration decreased by a factor of 2–3 from the V-SCRT and Z-SCRT cruise cycles—suggesting SCR catalyst's role on nucleation. Unlike cruise or UDDS cycles, idle runs are characterized with remarkably low particulate number emission rates, coupled with broad size distributions (Fig. 2a, b). The second test engine, Engelherd-DPX® (Fig. 2c) displays a dominant nucleation mode, almost identically to the SCRTs/CRT. It has been hypothesized that the catalyst wash-coat on DPF (if saturated) may be enhancing the conversion of SO_2 to SO_3/sulfate and partially stimulates the nucleation process (Hansen et al., 2001).

Contrary to the general notion that particulate filters augment nucleation, the hybrid vehicles (with a CCRT®) and the school bus (with an EPF) were found to be highly efficient in suppressing if not eliminating this PM mode. The Hybrid-CCRT® vehicle (Fig. 2d) resulted in concentrations (CVS) in the range of $\sim 10^4$ particles cm^{-3}, thus a 1000-fold improvement over the previously tested vehicles ($>10^7$ particles cm^{-3}). We hypothesize that the initial capacity of its relatively new trap (with only 1000 miles on it) to store sulfur has significantly suppressed the formation of nuclei mode particles. Once all the storage sites are saturated, nucleated sulfate particles are expected (Kittelson et al., 2006). For this vehicle, only a few odd large particles are left downstream (Fig. 2d). The school bus (Fig. 2d), however, was the cleanest amongst the entire test fleet with number emissions <1500 particles cm^{-3} measured in the CVS. It is important to note here that this vehicle is equipped only with an uncatalyzed filter (EPF), which is least likely to enhance the nucleation process. Thus, nucleation is not only control device specific but also a function of age and operating conditions, e.g. temperature of the catalysts.

The baseline truck, on the other hand, represents the older genre of vehicles and was found to emit substantial amounts of larger particles (Fig. 2f) with modes in the 60–100 nm range. Because of their large surface area, these accumulation mode particles act as adsorption sites and thus perfect sinks for organic vapors, leading to suppression of nucleation mode (Liu et al., 2007b).

3.2. *Size segregated mass emission factors*

Size fractionated mass emissions factors (in $mg\,km^{-1}$ or $mg\,h^{-1}$) are calculated based on the loadings on the MOUDI-nano-MOUDI impaction plates. The mass loadings on the individual substrates are generally low for retrofitted vehicles and depending on size ranges variation in the order of 20–40% (standard deviation/mean; from few duplicate measurements) are observed.

Although a direct correspondence of mobility and aerodynamic diameters is not accurate without establishing some conversion factors, we can utilize the information from Table 2 to complement the mobility size distributions (Fig. 2) described before. Number and mass-based size distributions are found to be in reasonable agreement with each other in terms of their trends.

The emission factors are remarkably low (~1–12 mg km^{-1}) for the fleet operated with control technologies compared to the baseline vehicle (~80–316 $mg\,km^{-1}$). While the majority ($>95\%$) of PM mass is concentrated between 100 nm and 2.5 μm for the baseline truck, nuclei modes are clearly visible for vehicles retrofitted with control devices. Significant reduction ($>90\%$) of the mass is achieved for vehicles retrofitted with control devices.

Some general trends and inferences can be drawn from Fig. 2 and Table 2. Consistent with previous studies (Kittelson et al., 2006; Vaaraslahti et al., 2004) the majority of the control technologies evaluated here have promoted bulk production of nano-size (nucleation) particles during steady state and high-speed segment of transient running cycles. The cruise cycles on average generate higher nucleation and lesser accumulation mode particles than the UDDS cycles. The differences between these driving cycles are even more pronounced in mass distributions (Table 2): significant shifts towards larger sizes are apparent in UDDS runs due to increased emission of accumulation mode particles during the acceleration processes (Polidori et al., 2008). Aerosol formation mechanism, poorly understood till date, seems to be a function of vehicle type and driving conditions and retrofit design.

Fig. 3 is an informative graph showing a plot of number EFs vs. mass EFs (nano-MOUDI, except V-SCRT-Cruise) for each vehicle and driving cycle. Each data point corresponds to a cruise or an UDDS cycle for a given vehicle. The graph shows that for several of the after-treatment devices tested, particle number emissions increase with reduced mass emissions. There are some outliers or exceptions observed for Z-SCRT at UDDS cycle, Hybrid-CCRT®, EPF and Idle (not shown) for which both number and mass EFs are relatively low. Thus, most of the new after-treatment devices appear to be highly efficient in reducing mass emissions but some are not effective in controlling number concentrations due to the formation of nuclei mode particles. These findings are potentially very important if number-based standards are considered in the future.

3.3. *Particle volatility*

The extent of particle volatility in terms of total count is illustrated quantitatively by the reduced variable 1 (R) plotted in Fig. 4 for various vehicles and cycles. R was calculated at 150 and 230 °C except in few occasions (Hybrid-CCRT®, EPF) when both the thermodenuders were operated at 150 °C to maximize our capability to collect mass of non-volatile particles. Theoretically, this ratio (R) should be greater or equal to unity and its increase corresponds to higher particle volatility. For the majority of the cases, R at 230 °C is at least an order of magnitude higher than their counterparts at 150 °C, indicating complete disappearance of large fraction of particles within this temperature window.

Particle volatility was also observed to be somewhat sensitive to driving conditions and type of control technology used. For instance, cruise mode particles are

Table 2
Size-fractionated mass EFs ($mg\,km^{-1}$ for cruise and UDDS, $mg\,h^{-1}$ for idle)

Size (nm)	V-SCRT		Z-SCRT			DPX			Hybrid-CCRT	CRT		EPF			Baseline		
	UDDS	Idle	Cruise	UDDS	Idle	Cruise	UDDS	Idle	UDDS	Cruise	UDDS	Cruise	UDDS	Idle	Cruise	UDDS	Idle
10–18	0.73	3.18	0.90	0.17	1.06	0.65	0.56	4.91	0.26	1.35	1.25	0.04	0.05	5.92	1.02	1.39	19.363
18–32	1.44	2.48	1.48	0.34	3.54	0.29	0.46	1.89	0.12	0.86	1.52	0.22	0.08	3.48	1.96	2.54	60.241
32–56	2.46	1.77	1.60	0.32	1.42	0.30	1.25	12.45	0.22	0.98	3.19	0.12	0.16	5.92	5.96	10.7	565.83
56–100	1.36	4.25	1.15	0.17	0.35	0.11	0.60	3.40	0.33	0.49	0.55	0.14	0.10	4.53	9.98	19.6	600.26
100–180	0.86	12.03	0.53	0.62	3.54	0.27	0.41	7.92	0.17	0.57	1.52	0.07	0.05	3.13	29.4	86.8	2327.9
180–2500	1.07	7.78	0.97	0.55	0.00	0.21	0.20	3.02	0.57	1.15	2.63	0.15	0.29	8.71	31.1	192	6049.9
>2500	0.83	6.37	0.50	0.66	3.18	0.20	0.35	5.66	0.35	0.37	0.83	0.12	0.17	7.66	1.03	3.41	346.39

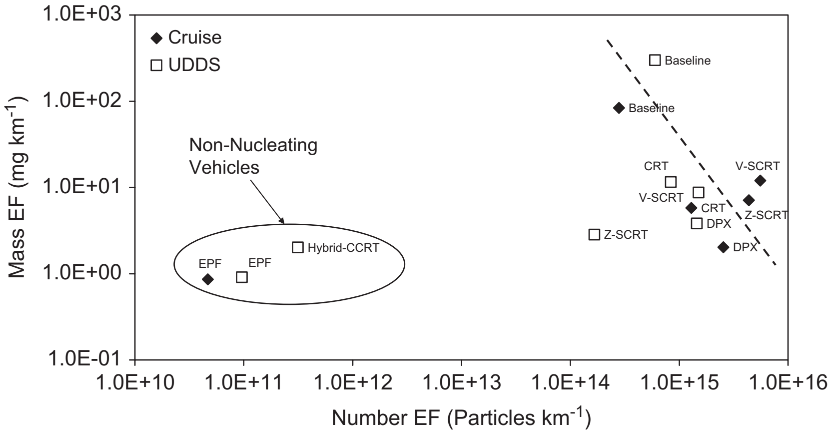

Fig. 3. Number (DMS) and mass emission factors (EF) (nano-MOUDI).

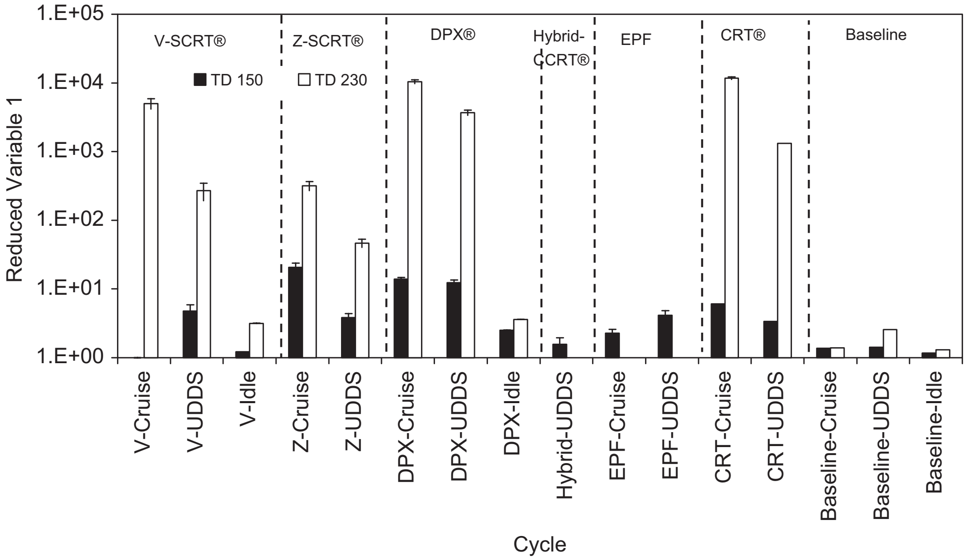

Fig. 4. Reduced variable 1 (*R*): ratio of total particle to solid or thermodenuded particle count.

extremely volatile with maximum *R*-values (~4000–10,000) at 230 °C for V-SCRT®, DPX® and CRT®. The fact that <~0.1% of particles persisted at 230 °C for most of the fleet with control technologies can logically be explained by the presence of unstable (volatile) fresh nano particles. Although the same Kenworth truck is used to evaluate various after-treatment devices (V-SCRT®, Z-SCRT®, CRT®), the Zeolite catalysts, especially during UDDS runs, seem to emit particles with a slightly higher heat resilience, which is consistent with the fact that nucleation mode particle were in lower concentrations for that vehicle and cycle (Fig. 2b). As expected, the baseline vehicle had the highest fraction of non-volatile particles in all cycles. Lower volatility is also observed during all idle runs, EPF and Hybrid-CCRT® vehicles. While we expect the baseline truck to emit large amounts of refractory elemental carbon, lower number loss for other vehicles/cycles should be attributed to their insignificant particle emission rate and/or absence of the nucleation mode particle formation.

The significant particle number loss between 150 and 230 °C, especially for cruise cycles, may be better elucidated by the evaporation profiles shown in Fig. 5. The majority of particles in the 7–20 nm size range for DPX® and CRT® have disappeared as the aerosol stream is heated from 150 to 230 °C. This is in total contrast to the baseline vehicle, where no noticeable shift in size spectrum is observed. Matter et al. (1999a, b) reported very similar thermal desorption trends between 172 and 204 °C for particles sampled downstream of a DPF. These results further justify our temperature choices for the two thermodenuders, which will hopefully enable us to discern differences in

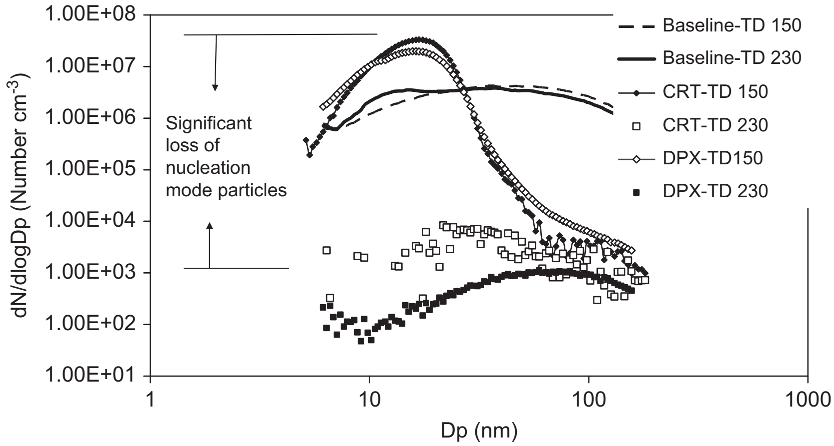

Fig. 5. Size distribution of thermodenuded aerosols for cruise mode.

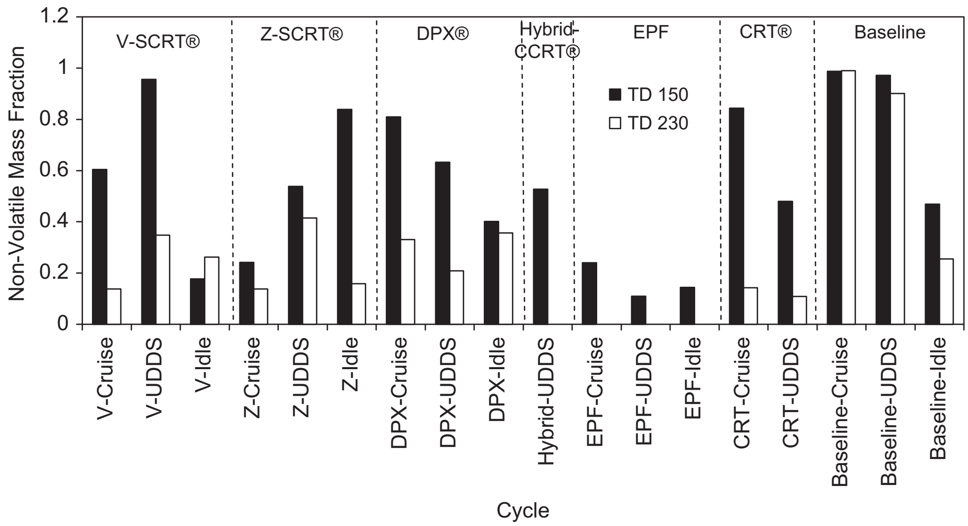

Fig. 6. Non-volatile mass fraction at different thermodenuder temperature settings.

the toxicological responses associated with the nucleation mode on particles of these different vehicles.

Fig. 6 presents the amount of mass fraction retained (non-volatiles) at 150 and 230 °C. We obtained these ratios from gravimetric filter measurement of denuded and undenuded samples. Particle number is not a good surrogate of its mass. Thus, except in the case of baseline vehicle, number loss (Figs. 4 and 5) has not linearly translated into equivalent particle mass reduction. While >99% of the particles completely disappear at 230 °C for SCRTs, CRT and DPX at cruise and UDDS runs, an appreciable fraction of mass (20–40%) remains intact. Quite a reverse trend is observed for idling, EPF and Hybrid-CCRT® (low-number emission scenarios with insignificant nucleation mode)—relatively low number volatility is accompanied with significant mass loss. A study (Biswas et al., 2007) conducted in close proximity of a freeway with the highest percentage of diesel fleet (~18%) in the USA demonstrated that a substantial amount of particle mass could be lost from larger ultrafine particles (>40 nm) due to heating without loosing a significant amount of their total counts. The mode of the size distribution shifted to lower size ranges, as a result of the depletion of the aerosol mass, but overall these particles simply decreased in size but did not disappear during heating, unlike the much smaller nucleation mode PM.

Particle volatility analysis could be used to at least in part infer particle chemical composition. Researchers have shown that diesel nuclei mode particles are dynamic mixtures of sulfate and organics (Grose et al., 2006; Scheer et al., 2005). Sulfates can either be in the form of pure sulfuric acid (classical binary nucleation theory of H_2SO_4–H_2O) or neutralized salts (NH_4SO_4, NH_4HSO_4, etc.). The neutralized species are refractory even at 200 °C; however, H_2SO_4 evaporates completely at a much lower temperature (~125–150 °C) due to its high vapor pressure (Orsini et al., 1999; Schmidt et al., 2002). The organic

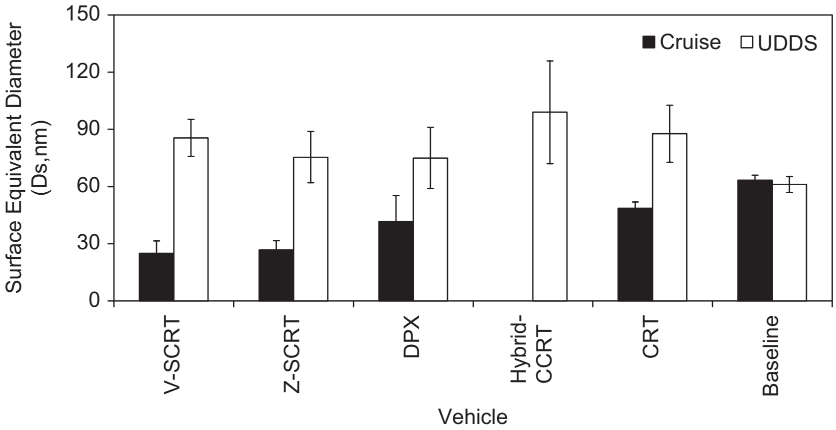

Fig. 7. Reduced variable 2: surface-rated diameter.

fraction is comprised not only of volatile unburned lube oil constituents, but also residual low vapor pressure organics (Tobias et al., 2001). From TEM analysis of particles captured downstream of a DPF, Mathis et al. (2004) further inferred that these nano-particles are likely to be composites of various species possessing diverse volatility characteristics. Although, from the above discussion, the bulk loss of nucleation mode particles in Figs. 4 and 5 appears to be due to evaporation of sulfates and volatile/semi-volatile organics between 150 and 230 °C, complete chemical speciation is essential to reach any educated conclusion and will be the topic of a subsequent publication of our group.

3.4. Particle surface properties

3.4.1. Reduced variable 2: surface-rated diameter

The surface-rated diameters (D_s) calculated from EAD surface concentrations are illustrated in Fig. 8. Ideally, D_s should be very close, if not higher than the arithmetic mean particle diameter. Average surface-rated diameters are calculated for all the vehicles except for school bus (EPF) where EAD signals are below the instruments detection limit. It is evident from the plot that cruise mode D_s, irrespective of types of control technologies, are smaller (~25–40 nm) compared to the transient driving cycles (~75–100 nm). This is consistent with the increased formation of elevated level of nuclei mode particles ($<$50 nm) during the steady state and larger amount of accumulation mode particles in UDDS cycles. Considering negligible variations in the accumulation modes (Harris and Maricq, 2001), also shown in Fig. 2 and Table 2, we can thus use D_s as a good indicator for the presence or absence of freshly nucleated particles.

During a typical transient run (i.e. UDDS cycles), an engine experiences acceleration, deceleration, steady state, and idling phases, which result in frequent changes in exhaust particle characteristics in terms of their size distribution, total count and surface concentration. Acceleration and high-speed cruise modes produce significant number of small particles, followed by their absence during deceleration and idling. Thus, rapid variation in D_s coupled with higher accumulation modes (Fig. 2, Table 2) eventually translates into higher mean surface diameter for UDDS runs. This phenomenon can be elucidated succinctly by time series plots (Fig. 8a, b) of particle number, EAD response (fA) and corresponding mean surface diameter (D_s) for a selected DPX® UDDS run (Fig. 8a). EAD signals and total counts track each other well; however, the D_s plot follows a reverse trend. Surface diameter goes up and down (50–500 nm) at the initiation of acceleration or deceleration when the total count is still low, or drops down drastically. The lowest surface diameter (~20–30 nm) was recorded during the later stages of acceleration, or at high-load conditions (steady state) as small particles predominate the size distribution.

Unlike the other vehicles (where similar behavior observed as that of Fig. 8a), the baseline truck maintains a high particle number concentration ($>10^6$ particle cm^{-3}) over the entire span of the UDDS runs, which greatly dampens the fluctuation in D_s (Fig. 8b). This explains its resultant lower mean surface diameter (~60 nm) (Fig. 7) despite the significant contribution of accumulation mode particles. Also, the lower difference in D_s for the cruise and UDDS can be attributed to the relatively higher number of nucleation mode particles in UDDS than cruise unlike other vehicles.

3.4.2. Reduced variable 3: mass specific surface concentration

Fig. 9 shows mass specific surface concentrations for the various vehicles and driving cycles tested. This PM property is inversely proportional to the mean particle size of DEPs, thereby providing an indirect measure of the extent of particle agglomeration. Therefore, the decrease of 'A' implies an increased contribution of coagulated or accumulation mode particles. The accumulation mode particles scavenge nucleation precursor species (Liu et al., 2007b), as mentioned before. Thus, particle agglomeration is an important parameter to indicate suppression of nuclei mode particles.

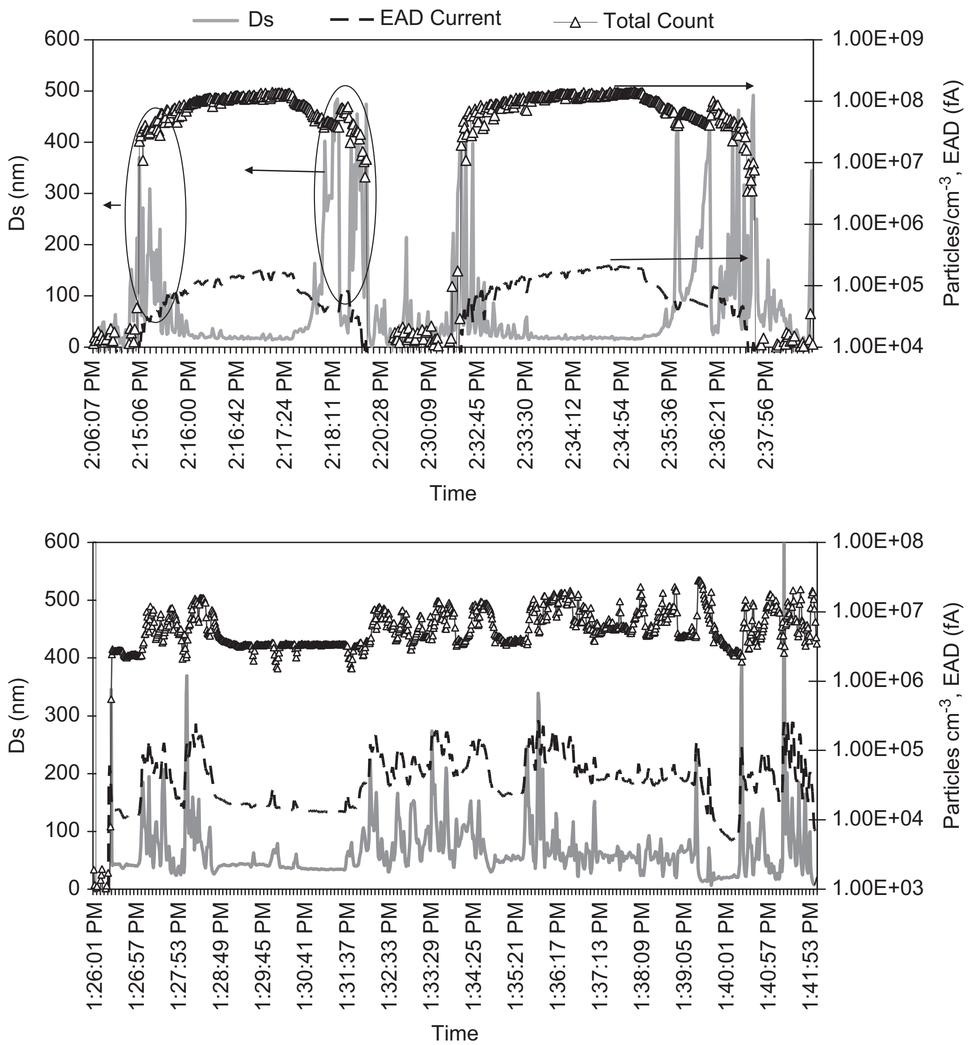

Fig. 8. Time series of surface diameter (D_s), surface concentration (EAD signal and total particle concentration (DMS count) for (a) Engleherd–DPX, (b) baseline–UDDS run.

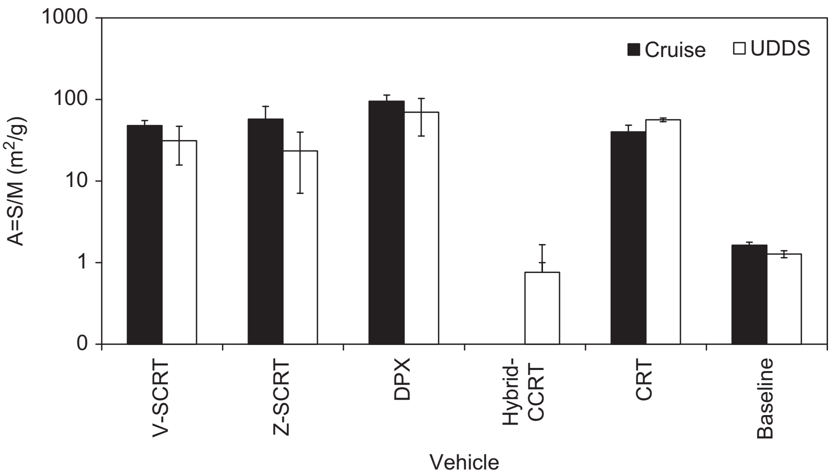

Fig. 9. Reduced variable 3: mass specific surface concentration.

The mass specific surface area, based on EAD surface concentration, have values in the range of 1–100 $m^2 g^{-1}$, which are consistent with those measured by Brunauer–-Emmett–Teller (BET) technique (26–72 $m^2 g^{-1}$, Duran et al., 2002). A study by Ntziachristos and Samaras (2006) reported somewhat higher values of the mass specific surface area from heavy-duty passenger vehicles (300–500 $m^2 g^{-1}$).

Cruise cycles on average have slightly higher values (5–10%) of '*A*' compared to their respective UDDS cycles of a given vehicle, indicating their less agglomerated particle structures. Although the shape and size of accumulation modes are quite similar, if not identical, for both cycles (Fig. 2), steady state operations are associated with higher nucleation mode. As EAD signal is weighed towards smaller particles (Jung and Kittelson, 2005), cruise cycles are likely to trigger more EAD response than transient cycles. On the other hand, accumulation modes prevail over nucleation modes (Fig. 2) for Hybrid-CCRT® at UDDS runs and the baseline vehicle, resulting in lower mass specific surface concentrations (~1 $m^2 g^{-1}$). Higher fractal agglomerates emitted by the baseline vehicle may result in a lower value of *A*. The effect of nucleation is also observed for Z-SCRT-UDDS runs, which exhibited slightly lower (though statistically insignificant) '*A*' compared to other SCRTs configurations.

4. Summary and conclusion

This investigation presents some of the first detailed particle characterization for advanced NO_x and PM retrofits for heavy-duty diesel vehicles. The test fleet includes a diesel hybrid electric with a DPF (Hybrid-CCRT®), a continuously regenerating technology (CRT®), a vanadium-based SCR catalyst with a CRT® (V-SCRT®), a Zeolite-based SCR catalyst with a CRT® (Z-SCRT®), a DPX, and an EPF. An HDDV vehicle without emission controls served as the baseline vehicle. The fleet was tested under three driving cycles: cruise at 50 mph. UDDS and idle.

Remarkable reductions in PM mass emissions (>90%) were found for the test fleet compared to the baseline vehicle. However, enhanced nucleation mode particles were observed for some of the vehicles especially during cruise cycles. Comparing to cruise cycles, the UDDS cycles emit higher particle mass in the accumulation mode. Idle runs are characterized with remarkably low particle number emission rates, coupled with fairly broad size distributions. The Hybrid-CCRT® and EPF vehicles were efficient in controlling both mass and number emissions.

The majority of particles by number evaporated by heating the aerosol to 150–230 °C, suggesting the nucleation mode particles are predominantly internally mixed and consist of semi-volatile compounds. Particles from the test fleet (except Hybrid-CCRT®) have shown about 100-fold higher active surface area per unit mass than the baseline vehicle. Chemical and toxicological analysis of the volatile and non-volatile fractions of PM emissions from the test fleet are under way and will be reported in future publications.

Acknowledgments

This research is sponsored by the California Air Resources Board (CARB), California Energy Commission (CEC), and South Coast Air Quality Management District (SCAQMD) through Grant no. 05-308 to USC. The authors would like to thank Dr. Harish Phuleria, Dr. Michael Geller, Ning Zhi, Payam Pakbin, Mohammad Arhami, Ralph Rodas, and George Gatt for their valuable support during experimental phase. This research has not been subjected to CARB's peer and policy review, and official endorsements should not be inferred.

Appendix A. Supplementary materials

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.atmosenv.2008.03.007.

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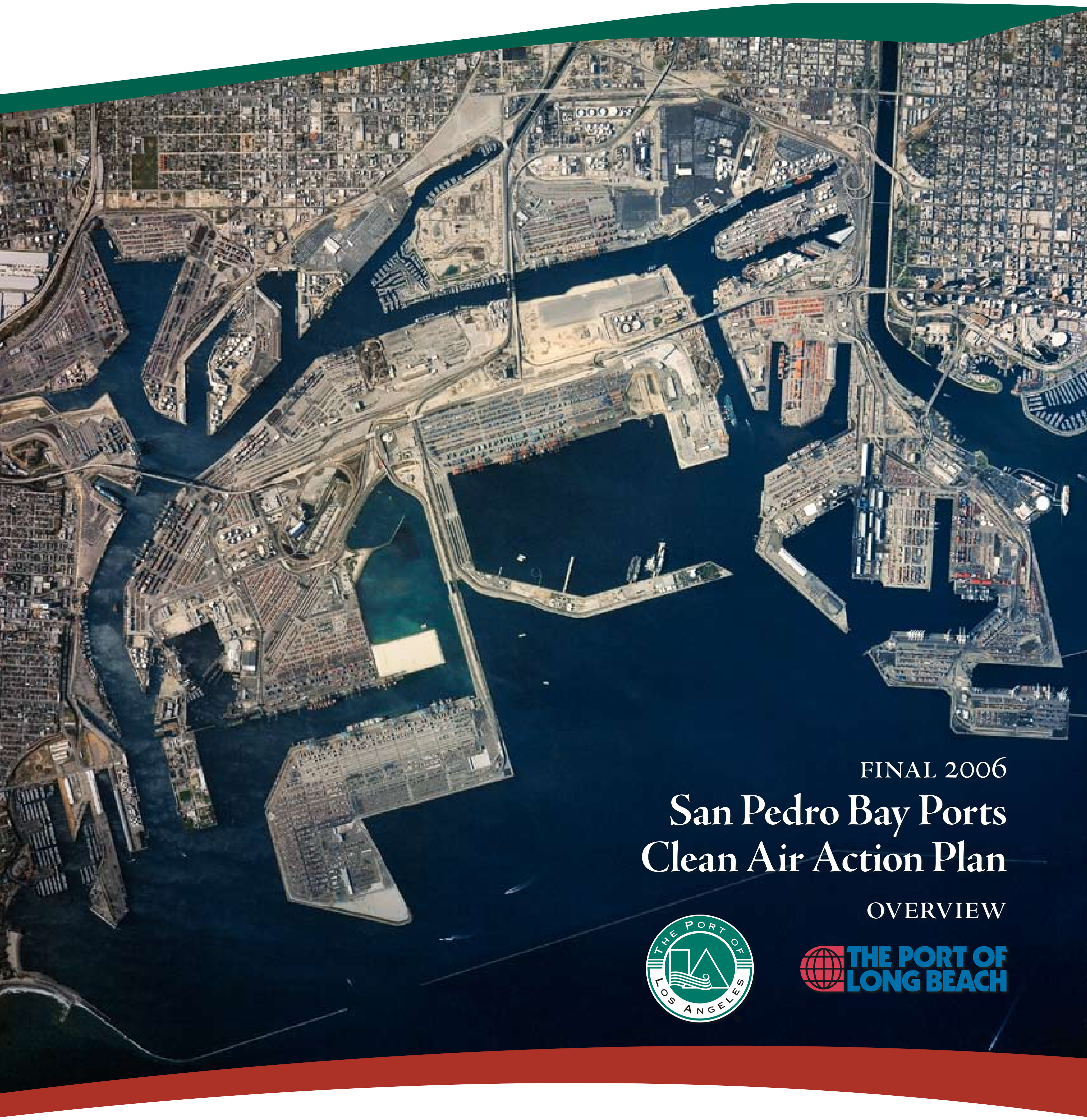

FINAL 2006

San Pedro Bay Ports Clean Air Action Plan

OVERVIEW

THE PORT OF LOS ANGELES

THE PORT OF LONG BEACH

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

California Environmental Protection Agency
Air Resources Board

AQMD

Prepared with the participation and cooperation of the staff of the US Environmental Protection Agency, California Air Resources Board and the South Coast Air Quality Management District.

STATEMENTS OF THE PRESIDENTS OF THE LOS ANGELES BOARD OF HARBOR COMMISSIONERS AND THE LONG BEACH BOARD OF HARBOR COMMISSIONERS

At the Joint Special Meetings of the Los Angeles Board of Harbor Commissioners and the Long Beach Board of Harbor Commissioners (the "Commissions") held on Monday, November 20, 2006, at 1:00 P.M. in the Long Beach City Council Chamber, 333 W. Ocean Blvd., Long Beach, California, the two Commissions unanimously adopted the San Pedro Bay Ports Clean Air Action Plan ("CAAP" or "Plan") as reflected in the minute record of the proceedings. At the meeting, the Presidents of the Commissions made the following statements, findings and proposed amendments which were incorporated into the Clean Air Action Plan that was approved by the Commissions:

First, we agree with the demand of many of those who commented on the Plan that there must be measurable goals so the public can have a yardstick to measure progress. So, we propose that we commit to a goal of reducing particulate emissions in 2008 by at least 15% from what it would be without the Plan, ratcheting up each year to at least a 45% reduction in 2011.

Second, we think we need to recognize that ultrafine particles are probably the most damaging of the fossil-fuel related air pollutants to human health. Accordingly, we propose that the staffs of the two Ports be directed to work with the USC Research Group on Ultrafine Particles to present the results and suggested next steps to the two Commissions no later than July 1, 2007. In addition, our new Technology Advancement Program must include ways to eliminate emissions of ultrafine particles, which in reality, in our view, means moving towards carbon-free fuels.

Third, we should recognize that the recently enacted California Global Warming Solutions Act of 2006 (AB32) requires carbon emissions be reduced back to 1990 levels by the year 2020. In light of the growth prospects of the two Ports, that means we must switch to carbon-free fuels (for example, green electricity) and other carbon-free technologies in every possible application as soon as possible. Toward that end, we propose that our respective staffs include such technology in our Technology Advancement Program. As part of that effort, the Ports pledge to contribute, and raise from other interested parties, the many millions needed to fund this vital effort.

Also, there is one technical amendment we offer to make clear that implementation of the individual Plan measures are subject to additional CEQA review, a fact that is beyond dispute and in the interest of all parties. We therefore move that on page 19 of the Overview and page 24 of the Technical Report the three words after "conducted" be stricken and replaced with "subject to CEQA statute, regulations and guidelines".

Both the environmental organizations and the business communities have expressed a desire for a continuous process for participation in the ongoing review and improvement of the Clean Air Action Plan in the months and years ahead. We welcome such participation. We therefore urge ALL groups to provide the Ports, within the next 30 days following adoption of the CAAP [by December 20, 2006], their ideas for how such public participation can best be conducted. We will promptly approve and implement that process within 30 days after receipt and review of their ideas.

A critical initiative in the Plan is a massive effort to deal with the well-recognized problem of heavily polluting trucks driven by under-paid drivers. These trucks produce 10% of the Port-related diesel particulate emissions and fully 25% of the NOx emissions. The Ports have identified over 16,000 individual vehicles that make 80% of the trips to and from Port terminals, so cleaning up those vehicles would eliminate a significant portion of Port-related air pollution.

That will be a hugely expensive effort that will involve replacing many trucks and retrofitting others with pollution control devices. The Commissioners of both Ports believe that we can tackle the dirty truck problem in a manner consistent with the Clean Air Action Plan. Accordingly, we direct our respective staffs to work expeditiously to bring forward a plan with the following elements for further future approval of these boards:

a. The Ports undertake a 5-year, focused effort to replace or retrofit the entire fleet of over 16,000 trucks that regularly serve our Ports with trucks that at least meet the 2007 control standards and that are driven by people who at least earn the prevailing wage.
b. The Ports establish within their respective districts a program that restricts the operation of trucks that do not meet the clean standards established in the Plan. Further, that we impose a system of fees and transportation charges to raise the necessary funds to pay for the cleaner trucks. These fees would be imposed on "shippers", and not on the drivers.
c. The Ports will invite private enterprise trucking companies to hire the drivers on terms that offer the proper incentives and conditions to achieve the Clean Air Action Plan goals while resulting in adequately paid drivers.
d. The Ports begin this program with an infusion of cash to the Gateway Cities Program that would fund a 500-truck program that will demonstrate the applicability of new retrofit technologies. This demonstration program will be activated in the 1st quarter of 2007, and the full 16,800-truck program will be rolled out shortly thereafter.
e. The Ports develop requests for proposals that will encourage truck fleets of alternatively-fueled vehicles, for example, LNG.

We believe that we can count on the support of our private industry and government partners in this effort.

We believe that this program would enable the Ports to achieve one of the major goals of the Clean Air Action Plan quickly and with minimum economic impact to the people who can least afford to absorb extra costs, namely the hard-working truck drivers who move so much of the cargo.

That leads to our second point, which is the issue of monetary incentives. Many people have commented that the Ports need to pay to clean up pollution from Port operations. Both Boards want to make it clear that the Ports cannot and will not subsidize the cost of cleaner transportation indefinitely. Those expenses are a legitimate cost of doing business, and we believe that our position will ensure that companies engaged in goods movement pay their fair share of the cost of cleaning up our air and protecting our citizens. Accordingly, it is our policy that monetary payments by the Ports for cleaner technologies and fuels will be granted to true pioneers in the industry, but only for short periods of time. After that, each entity must bear the costs of reducing pollution from its operations.

FOREWORD

To effectively integrate common goals for air quality in the South Coast Air Basin, the Port of Los Angeles (POLA) and the Port of Long Beach (POLB) have worked together in close coordination with the staff of the South Coast Air Quality Management District (SCAQMD), the California Air Resources Board (CARB), and the United States Environmental Protection Agency Region 9 (EPA Region 9) to develop the San Pedro Bay Ports Clean Air Action Plan. This Plan is the first of its kind in the country, linking the emissions reduction efforts and visions of the two largest Ports in the United States with similar efforts and goals of the regulatory agencies in charge of ensuring compliance with air quality standards. The collaborative effort will continue in the years to come with the review and update of the Clean Air Action Plan on an annual basis.

The air agencies have extensively reviewed and commented on the draft Plan, support the collaborative process that has been established, and support the goals delineated in the Plan. By participating in the development and annual review of this Plan, these regulatory agencies do not waive or forfeit their rights or obligations to continue to regulate emissions sources under their control. Participation in this process is voluntary by all parties and does not in any way inhibit or preclude agencies from any legal authorities and responsibilities to meet federal, state, and local air quality standards. Participation does not mean that the agencies necessarily endorse each of the measures and concepts proposed in the Plan.

WHAT'S IN THE CLEAN AIR ACTION PLAN?

- **Final 2006 San Pedro Bay Ports Clean Air Action Plan Overview**
- Final 2006 San Pedro Bay Ports Clean Air Action Plan Technical Report
- Final 2006 San Pedro Bay Ports Clean Air Action Plan Comments Compendium

For additional information see:

- Port of Los Angeles website: www.portoflosangeles.org
- Port of Long Beach website: www.polb.com


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INTRODUCTION

This document is the first San Pedro Bay Ports Clean Air Action Plan (Clean Air Action Plan). This joint Clean Air Action Plan describes the measures that the Ports of Los Angeles and Long Beach will take toward reducing emissions related to port operations. In March 2006, a groundbreaking meeting occurred at the highest level between the two Ports and the South Coast Air Quality Management District (SCAQMD) where all parties expressed the need to work jointly toward solutions. Shortly thereafter, the Ports engaged the California Air Resources Board (CARB) and the United States Environmental Protection Agency Region 9 (EPA Region 9) in the spirit of cooperation to help the Ports develop the Clean Air Action Plan for their respective Boards of Harbor Commissioners' approval. It should be emphasized that these entities have committed to continuing their efforts associated with the development, review, implementation, and update/revision of the Clean Air Action Plan on an annual basis.

The five-year Action Plan highlights the goals, emissions reductions, and budgetary needs for fiscal years (FY) 2006/2007 through 2010/2011. By the end of the five-year period, virtually all needed measures to meet the goals will be in place. Staff from both Ports intend to regularly evaluate progress towards meeting the Clean Air Action Plan goals, review status of existing control measures, evaluate new measures, and jointly develop a revised action Plan each year.

THE HISTORY

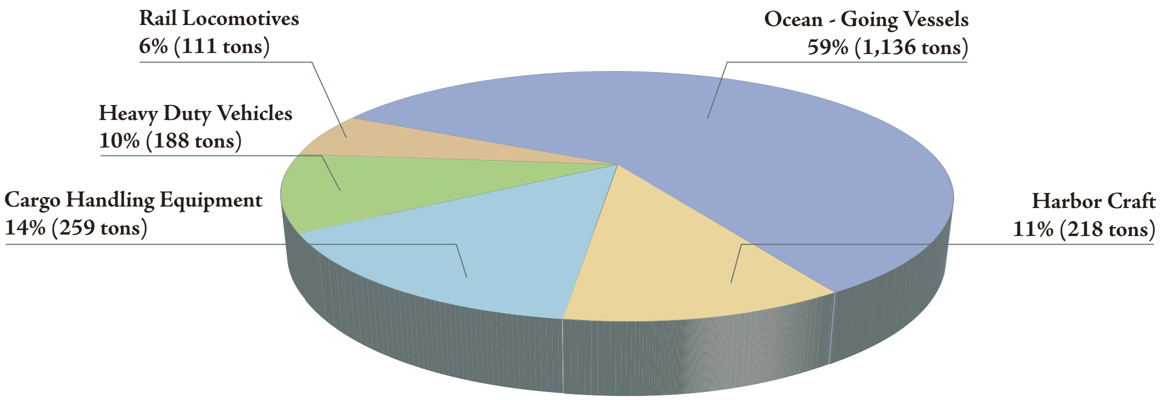
In the early 1900s, the State conveyed the Port tidelands to Los Angeles and Long Beach, as trustees for the people of the State of California, to accommodate and promote harbor commerce, navigation and fisheries. The Ports are landlord ports; they build terminal facilities and lease them to shipping lines and stevedoring companies. The Ports do not operate the terminals, ships, yard equipment, trucks or trains that move the cargo. However, the Ports are determined to accelerate the effort to reduce air pollution from "goods movement" activities using all the powers available to them.

The San Pedro Bay Ports (SPBP) comprise a huge regional and national economic engine. The Los Angeles Customs District accounts for approximately $300 billion in annual trade. More than 40% of all containerized trade in the nation flows through the SPBP. Economic forecasts suggest that the demand for containerized cargo moving through the San Pedro Bay region will more than double by the year 2020.

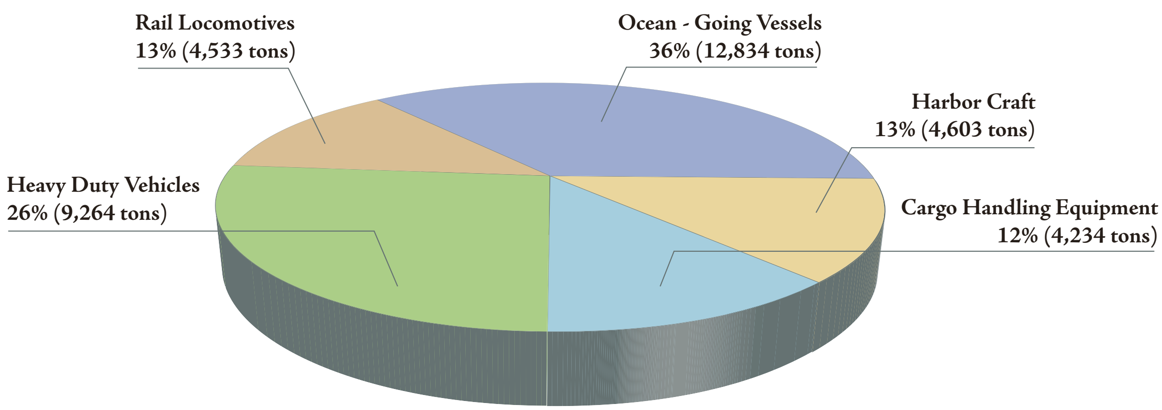
PORT-RELATED EMISSIONS

Based on the baseline year emissions inventories for both Ports (2001/2002), the contribution of emissions by the five port-related source categories, and their percentage share compared to the South Coast Air Basin (SoCAB), are presented in following figures.

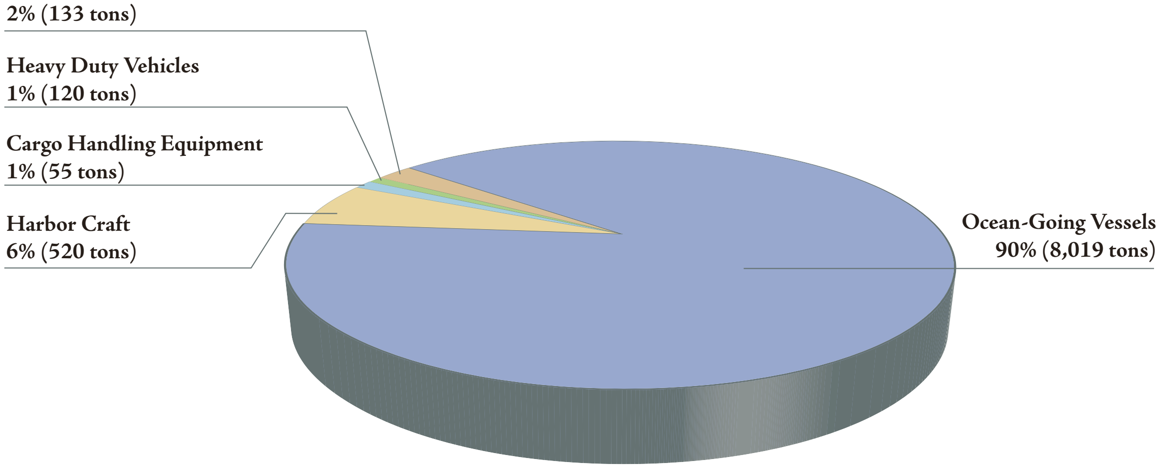
Baseline Year DPM Emissions Contributions by Source Category



Baseline Year NOx Emissions Contributions by Source Category

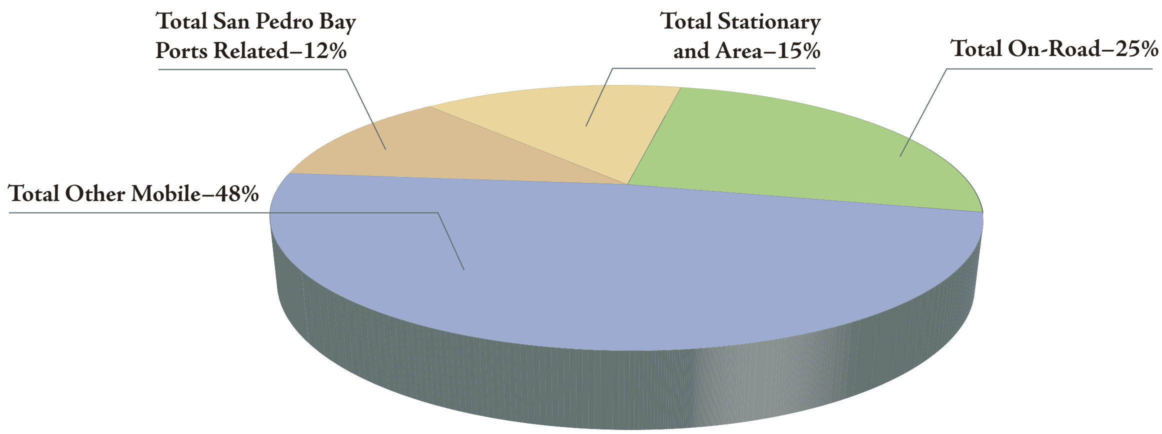


Baseline Year SOx Emissions Contributions by Source Category

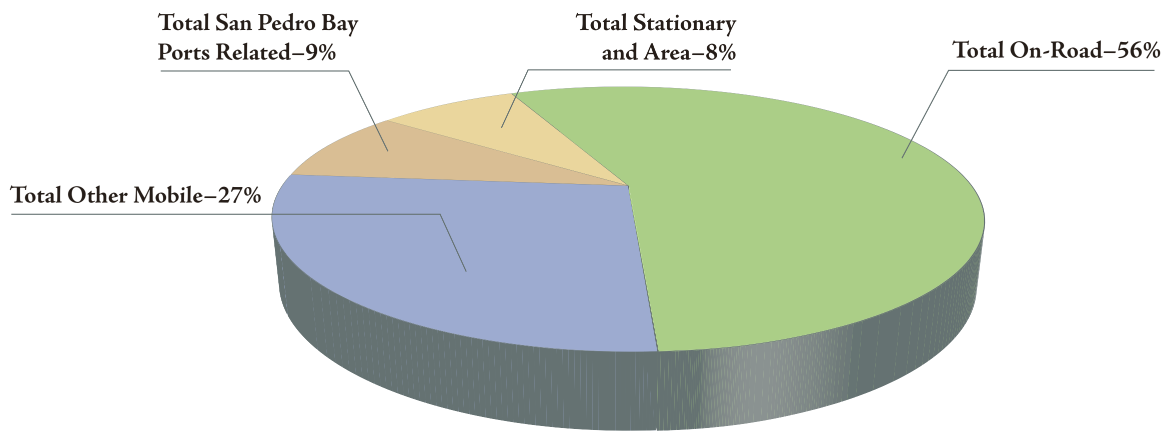


The following figures compare the San Pedro Bay Port percentage contributions, with the contributions from all the emissions sources in the SoCAB for the baseline year.

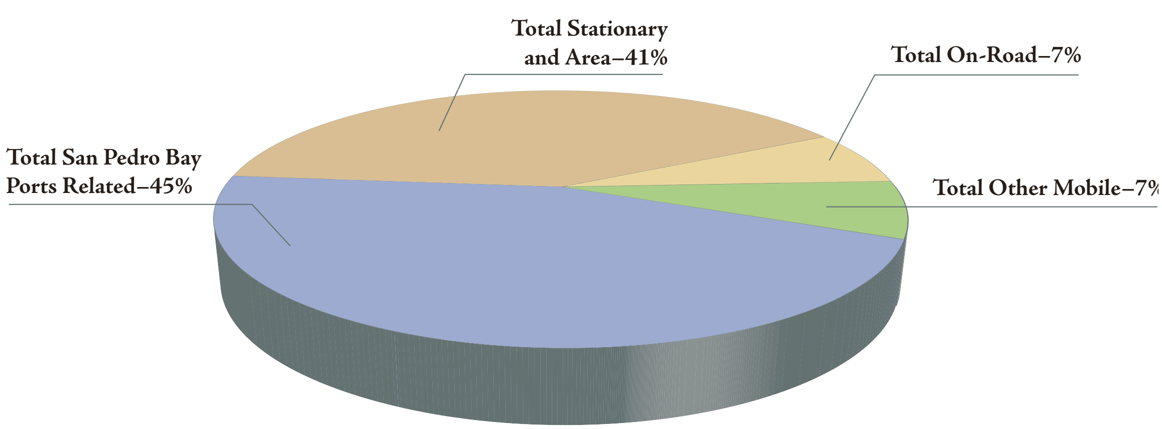
Baseline Year SPBP vs. SoCAB DPM Emissions Contributions



Baseline Year SPBP vs. SoCAB NOx Emissions Contributions



Baseline Year SPBP vs. SoCAB SOx Emissions Contributions



The Ports and regulatory agencies acknowledge that if port-related sources are not controlled by the Clean Air Action Plan to reduce their "fair share" with respect to the other sources in the SoCAB, port-related contributions to the basin's total emissions (particularly with respect to OGVs) will increase significantly beyond the levels presented above. Therefore, action must be taken now in order to help the basin meet its air quality goals.

Attachments from Comment Letter R148

Table 4.1: Guideline values for community noise in specific environments.

Specific environment	Critical health effect(s)	LAeq [dB]	Time base [hours]	LAmax, fast [dB]
Outdoor living area	Serious annoyance, daytime and evening Moderate annoyance, daytime and evening	55 50	16 16	- -
Dwelling, indoors Inside bedrooms	Speech intelligibility and moderate annoyance, daytime and evening Sleep disturbance, night-time	35 30	16 8	 45
Outside bedrooms	Sleep disturbance, window open (outdoor values)	45	8	60
School class rooms and pre-schools, indoors	Speech intelligibility, disturbance of information extraction, message communication	35	during class	-
Pre-school bedrooms, indoors	Sleep disturbance	30	sleeping -time	45
School, playground outdoor	Annoyance (external source)	55	during play	-
Hospital, ward rooms, indoors	Sleep disturbance, night-time Sleep disturbance, daytime and evenings	30 30	8 16	40 -
Hospitals, treatment rooms, indoors	Interference with rest and recovery	#1		
Industrial, commercial shopping and traffic areas, indoors and outdoors	Hearing impairment	70	24	110
Ceremonies, festivals and entertainment events	Hearing impairment (patrons:<5 times/year)	100	4	110
Public addresses, indoors and outdoors	Hearing impairment	85	1	110
Music through headphones/ earphones	Hearing impairment (free-field value)	85 #4	1	110
Impulse sounds from toys, fireworks and firearms	Hearing impairment (adults) Hearing impairment (children)	- -	- -	140 #2 120 #2
Outdoors in parkland and conservation areas	Disruption of tranquillity	#3		

#1: as low as possible;
#2: peak sound pressure (not LAmax, fast), measured 100 mm from the ear;
#3: existing quiet outdoor areas should be preserved and the ratio of intruding noise to natural background sound should be kept low;
#4: under headphones, adapted to free-field values

GUIDELINES FOR COMMUNITY NOISE

Edited by

Birgitta Berglund
Thomas Lindvall
Dietrich H Schwela

This WHO document on the *Guidelines for Community Noise* is the outcome of the WHO-expert task force meeting held in London, United Kingdom, in April 1999. It bases on the document entitled "Community Noise" that was prepared for the World Health Organization and published in 1995 by the Stockholm University and Karolinska Institute.

World Health Organization, Geneva
Cluster of Sustainable Development and Healthy Environment (SDE)
Department for Protection of the Human Environment (PHE)
Occupational and Environmental Health (OEH)

Environmental Justice Community Noise Standard

1. Environmental Justice Community Noise Standard

Environment	Day 7:00am – 5:00pm	Night 5:00pm-7:00am	Night Sleep Time 9:00pm – 7:00am
Outdoor	50dBA	40dBA	
School Indoor	35dBA	35dBA	
Preschool Sleep Time	30dBA		
Residence Indoor	35dBA	35dBA	
Residence Indoor Sleep Time			30dBA
Residence Indoor Low Frequency			25dBA

1.1 General Ambient Noise Level

Los Angeles Noise Ordinance – Chapter XI Noise Regulation, Article 1 General Provisions Sec. 111.00 Declaration of Policy and Sec. 111.03 Minimum Ambient Noise Level Table II Zone A1, A2, RA, RE, RS, RD, RW1, RW2, R1, R2, R3, R4, R5 Presumed Ambient Noise Level Day dBA 50 and Night 40dBA and Article 6 General Noise Sec.116.01 Loud, Unnecessary and Unusual Noise.

1.2 Community Ambient Noise Protection

World Health Organization – Guidelines for Community Noise, Table 1 & Table 4.1 Guidelines Values for Community Noise in Specific Environments – Specific Environment: Inside Bedrooms 30dBA, Preschool Sleep 30dBA and School Class Rooms 35dBA.

1.3 Specific Low Frequency Noise Protection

World Health Organization – Guidelines for Community Noise, 4.2.3 Sleep Disturbance Effects states, “For noise with a large proportion of low frequency sounds a still lower guideline lower than 30dBA is recommended,” and “Since A-weighting underestimates the sound pressure level of noise with low frequency components, a better assessment of health effects would be to use C-weighting.”

1.4 American Industry Standard

The American National Standards Institute (ANSI) ANSI S12.60-2002 Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Table 1 pg. 5 for Learning space 35dBA.

Environmental Justice Project Community Advisory Committee

1.0 Project Community Advisory Committee Purpose

TBD

2.0 PCAC Goals & Objectives

TBD

3.0 PCAC Membership

Community Advisory Committee membership shall consist of 80% local residents, 10% stakeholders and 10% representatives from local community organizations. All residents and stakeholder members must live in Wilmington, Long Beach or Carson.

4.0 PCAC Meetings

TBD

5.0 PCAC Website

TBD

6.0 Project Noise Monitoring Program

TBD

7.0 Project Traffic & Equipment Monitoring Plan

Preconstruction, Construction and Post Construction TBD

8.0 Community Noise Survey

8.1 Preconstruction Community Noise Survey
8.2 During Construction and Post Construction Community Noise Survey TBD.

9.0 Community Noise Complaint Procedure

4.1. Community Information & Complaint Hotline
4.2. Community Complaint Form
4.3. Complaint Investigation
4.4. Problem Corrective Action
4.5. Complaint Resolution

9.0 Project Noise Monitoring Status Reporting

TBD

10.0 Community Complaints Status Reporting

TBD

11.0 PCAC Termination

TBD.

Environmental Justice Community Preconstruction Noise Survey

1. The community should have a say in defining the Community Noise Standard?

   Strongly Agree [ ]   Agree [ ]   Disagree [ ]   Undecided [ ]

2. The community should have a say in determining construction work days and hours?

   Strongly Agree [ ]   Agree [ ]   Disagree [ ]   Undecided [ ]

3. There should be no construction work on weekends and holidays?

   Strongly Agree [ ]   Agree [ ]   Disagree [ ]   Undecided [ ]

4. All construction contractors and subcontractor workers should attend a noise class?

   Strongly Agree [ ]   Agree [ ]   Disagree [ ]   Undecided [ ]

5. The noise standards should provide the maximum public health & welfare protection?

   Strongly Agree [ ]   Agree [ ]   Disagree [ ]   Undecided [ ]

6. Indoor school classrooms should have a stricter noise standard than day?

   Strongly Agree [ ]   Agree [ ]   Disagree [ ]   Undecided [ ]

7. Preschool classrooms should have a stricter noise standard than day?

   Strongly Agree [ ]   Agree [ ]   Disagree [ ]   Undecided [ ]

8. Senior housing & Hospice Facilities should have a stricter noise standard than day?

   Strongly Agree [ ]   Agree [ ]   Disagree [ ]   Undecided [ ]

9. Hospitals should have a stricter noise standard than day?

   Strongly Agree [ ]   Agree [ ]   Disagree [ ]   Undecided [ ]

10. Day time residential near Intermodal facilities should have a stricter noise standard?

    Strongly Agree [ ]   Agree [ ]   Disagree [ ]   Undecided [ ]

11. Night time residential areas should have a stricter noise standard than day?

    Strongly Agree [ ]   Agree [ ]   Disagree [ ]   Undecided [ ]

12. Sleep times should have a stricter noise standard than standard night?

    Strongly Agree [ ]   Agree [ ]   Disagree [ ]   Undecided [ ]

13. A noise monitoring plan should be required as part of the project?

    Strongly Agree [ ]   Agree [ ]   Disagree [ ]   Undecided [ ]

14. A Community Advisory Committee should be required as part of the project?

    Strongly Agree [ ]   Agree [ ]   Disagree [ ]   Undecided [ ]

15. Penalties and fines should be established for noise violations?

Strongly Agree [ ] Agree [ ] Disagree [ ] Undecided [ ]

16. There should be a public information hotline & complaint line?

Strongly Agree [ ] Agree [ ] Disagree [ ] Undecided [ ]

17. Project Noise should be mitigated to eliminate and reduce noise to less than significant?

Strongly Agree [ ] Agree [ ] Disagree [ ] Undecided [ ]

18. Port truck traffic volume near residential homes & schools should be limited to prevent increasing noise?

Strongly Agree [ ] Agree [ ] Disagree [ ] Undecided [ ]

19. Port train traffic volume near residential homes & schools should be limited to prevent increasing noise?

Strongly Agree [ ] Agree [ ] Disagree [ ] Undecided [ ]

20. Project sponsors should require and provide incentives to purchase zero emissions and near noiseless trucks?

Strongly Agree [ ] Agree [ ] Disagree [ ] Undecided [ ]

21. Project sponsors should require and provide incentives to purchase zero emissions and hear noiseless trains?

Strongly Agree [ ] Agree [ ] Disagree [ ] Undecided [ ]

22. Schools, residential homes and all sensitive receptors locations should be sound proofed to eliminate noise or reduce to less than significant?

Strongly Agree [ ] Agree [ ] Disagree [ ] Undecided [ ]

23. Environmental and public health mitigation costs should be included in project budget?

Strongly Agree [ ] Agree [ ] Disagree [ ] Undecided [ ]

24. Excessive noise disturbs my ability to sleep?

Strongly Agree [ ] Agree [ ] Disagree [ ] Undecided [ ]

25. Excessive noise disturbs my mental peacefulness?

Strongly Agree [ ] Agree [ ] Disagree [ ] Undecided [ ]

26. Excessive noise disturbs my ability to relax, watch TV and listen to music?

Strongly Agree [ ] Agree [ ] Disagree [ ] Undecided [ ]

27. Excessive noise makes me unable to concentrate and perform my daily activities?

Strongly Agree [ ] Agree [ ] Disagree [ ] Undecided [ ]

28. Train & Truck noise is a major problem in my community and has been increasing?

Strongly Agree [ ] Agree [ ] Disagree [ ] Undecided [ ]

AMERICAN NATIONAL STANDARD

ACOUSTICAL PERFORMANCE CRITERIA, DESIGN REQUIREMENTS, AND GUIDELINES FOR SCHOOLS

Accredited Standards Committee S12, Noise

Standards Secretariat
Acoustical Society of America
35 Pinelawn Road, Suite 114E
Melville, NY 11747-3177

Environmental Justice Community Fence-Line Monitoring Program

1.0 Noise Monitoring Program

Complete detail description TBD.

2.0 Community Advisory Committee Establishment

Community Advisory Committee to be established 90 days before construction begins.

3.0 Environmental Justice Community Noise Standard

3.1 Environmental Justice Community Noise Standard

Environment	Day 7:00am – 5:00pm	Night 5:00pm-7:00am	Night Sleep Time 9:00pm – 7:00am
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World Health Organization – Guidelines for Community Noise, 4.2.3 Sleep Disturbance Effects states, "For noise with a large proportion of low frequency sounds a still lower guideline lower than 30dBA is recommended," and "Since A-weighting underestimates the sound pressure level of noise with low frequency components, a better assessment of health effects would be to use C-weighting."

3.5 American Industry Standard

The American National Standards Institute (ANSI) ANSI S12.60-2002 Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Table 1 pg. 5 for Learning space 35dBA.

4.0 Technical Approach

Community On-Site Monitoring Technical Approach TBD.

5.0 Real Time Ambient Noise Level Monitoring

5.1 Real Time Ambient Noise Level Monitoring shall as a minimum measure Leq, L10, Ldn, Lmax, SEL and CNEL. A-Frequency Weighting and C-Frequency Weighting shall be monitored and recorded.

5.2 All measurements must be continuous and recorded.

6.0 Real Time Noise Sound Recording

6.1 Real time ambient noise shall be recorded to determine source and types of noises.

6.2 Noise sound recording will be continuous non-stop recording either analog or digital 24hrs. per day with digital preferred.

7.0 Noise Sound Level Meter

7.1 The Noise Sound Level Meter shall be a Type I to ANSI S1.4-1998 or most recent revision.

7.2 A Sound Level Meter with data-logging capability for recording a minimum of 24 hrs. continuously recording and 7 days non-stop is preferred.

7.3 A Sound Level Meter capable of recording ambient noise sound a minimum of 24 hrs. continuously and 7 days non-stop is preferred.

7.4 Sound Level Meters, Data Logging and Sound Recording Equipment and accessories must be capable of withstanding outdoor inclement weather.

8.0 Noise Monitoring Locations

Locations TBD.

9.0 Noise Monitoring

Protocol TBD

10.0 Noise Monitoring Schedule

Schedule TBD.

11.0 Frequency of Noise Monitoring

11.1 Measurements shall as a minimum be every 15 minutes for 24hrs. per day or as may be determined necessary.

12.0 Equipment Calibration

12.1 Equipment calibration shall be traceable to the National Bureau of Standards and the American National Standards Institute (ANSI) S1.4-1998 or most recent revision.

12.2 Records shall be maintained and provided upon request.

13.0 Equipment Inspection & Monitoring

On-Site Equipment Inspection & Monitoring Plan TBD.

14.0 Record Keeping Procedures

Procedures TBD.

15.0 Noise Monitoring Quality Assurance

QA Plan TBD.

16.0 Noise Monitoring Reports

Noise Monitoring Reports will be produced monthly, quarterly and annually.

17.0 Data Analysis & Review

Format TBD.

18.0 Corrective Action

CA TBD.

NOISE CONTROL ACT OF 1972

HISTORY: Public Law 92-574, Oct. 27, 1972; 86 Stat. 1234; 42 USC 4901 et seq.; Amended by PL 94-301, May 31, 1976; PL 95-609, Nov. 8, 1978; PL 100-418, Aug. 23, 1988

SEC. 1 [42 U.S.C. 4901 nt], Short Title.

This Act may be cited as the "Noise Control Act of 1972."

SEC. 2 [42 U.S.C. 4901]Findings and Policy.

(a) The Congress finds--

(1) that inadequately controlled noise presents a growing danger to the health and welfare of the Nation's population, particularly in urban areas;

(2) that the major sources of noise include transportation vehicles and equipment, machinery, appliances, and other products in commerce; and

(3) that, while primary responsibility for control of noise rests with State and local governments, Federal action is essential to deal with major noise sources in commerce control of which require national uniformity of treatment.

(b) The Congress declares that it is the policy of the United States to promote an environment for all Americans free from noise that jeopardizes their health or welfare. To that end, it is the purpose of this Act to establish a means for effective coordination of Federal research and activities in noise control, to authorize the establishment of Federal noise emission standards for products distributed in commerce, and to provide information to the public respecting the noise emission and noise reduction characteristics of such products.

SEC. 3 [42 U.S.C. 4902] Definitions.

For purposes of this Act:

(1) The term "Administrator" means the Administrator of the Environmental Protection Agency.

(2) The term "person" means an individual, corporation, partnership, or association, and (except as provided in sections 11(e) and 12(a)) includes any officer, employee, department, agency, or instrumentality of

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Air Quality Appendices

AQ-1 Expert Witness Letter Dr. Jonathan Heller, PHD

AQ-2 Jonathan Heller CV

AQ-3 Health Impact Assessment Information

AQ-4 Medical Health Studies Index A-1 / A-10

Attachments from Comment Letter 50A-4

Proprietary Information

ZERO EMISSIONS ELECTRIC CONTAINER MOVING SYSTEM FOR THE PORTS OF LONG BEACH/LOS ANGELES

LSM Technology Program

A Joint Proposal by
INNOVATIVE TRANSPORTATION SYSTEMS CORP.
AECOM
GENERAL ATOMICS
MACQUARIE BANK

Presentation to California Energy Commission
April 27, 2009

Innovative Transportation Systems Corp.
An affiliate of Shapery Enterprises

AECOM

GENERAL ATOMICS ELECTROMAGNETIC SYSTEMS

THE TEAM

Innovative Transportation Systems Corp.

An affiliate of the Shapery group of Companies.

The Shapery Group of Companies, a major commercial real estate and technology developer. Headquarters in San Diego, CA

General Atomics

World's leader in high power linear motors. Founded 1955; Privately owned; 5,000 employees Business Areas: Defense; Energy; Transportation

AECOM

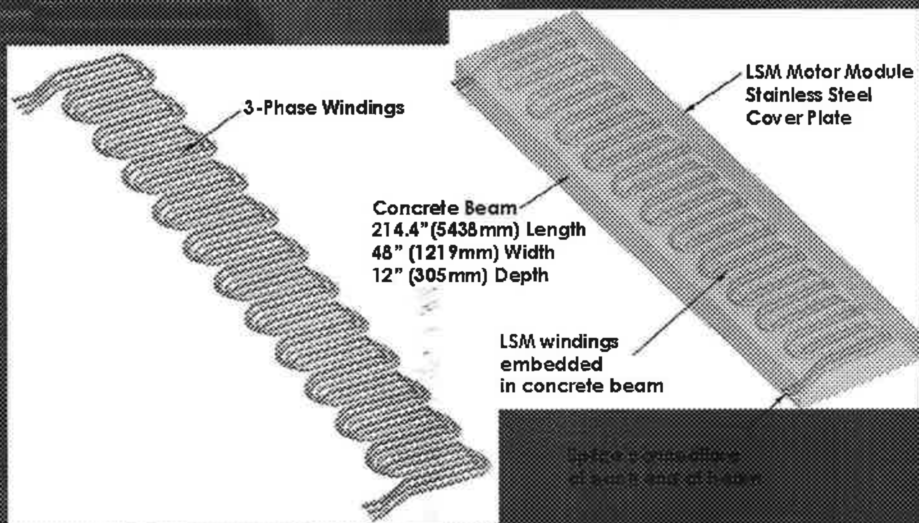
World's largest engineering and environmental company. Representing many Ports and Railroad projects worldwide. Designed Alameda Corridor. Headquarters in Los Angeles.

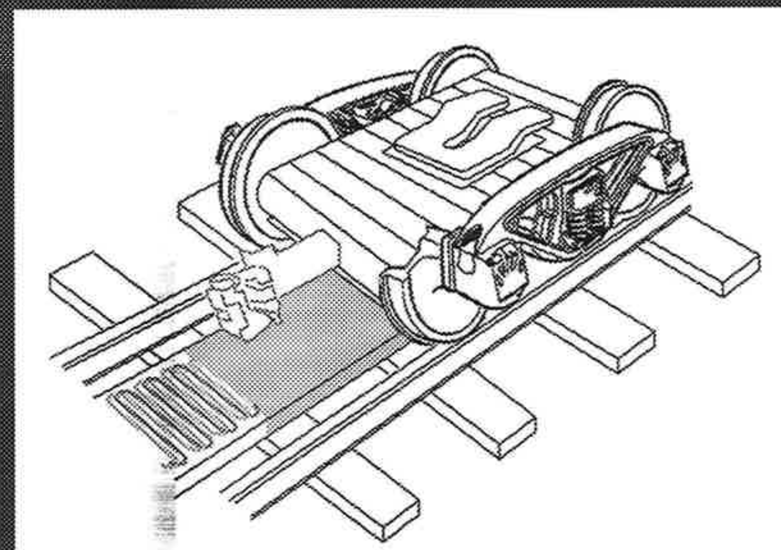
Macquarie Bank

The largest infrastructure bank in the world

LSM-Rail Technology - MagneTrack ™

- Linear motor incased in concrete
- and imbedded on railroad cross ties.

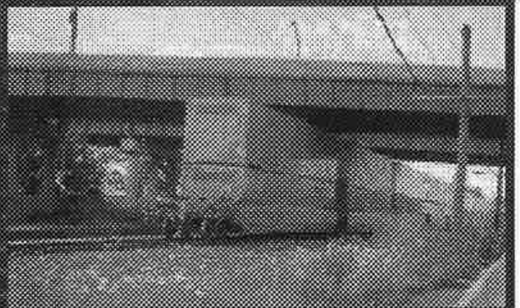




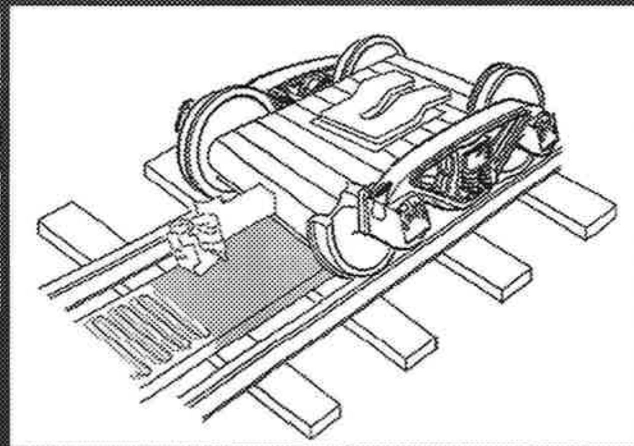
Motive force will be small bogies fitted with array of permanent magnets reacting with and running over imbedded linear motors on standard railway.

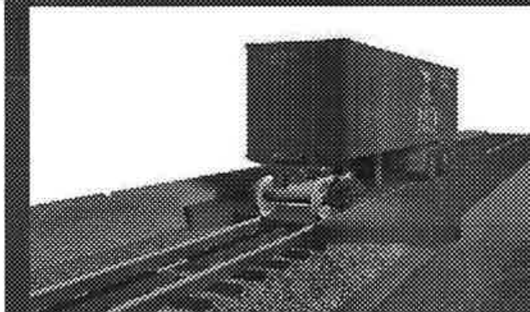
Proprietary Information

MagneTrack™ Potential Operating Modes

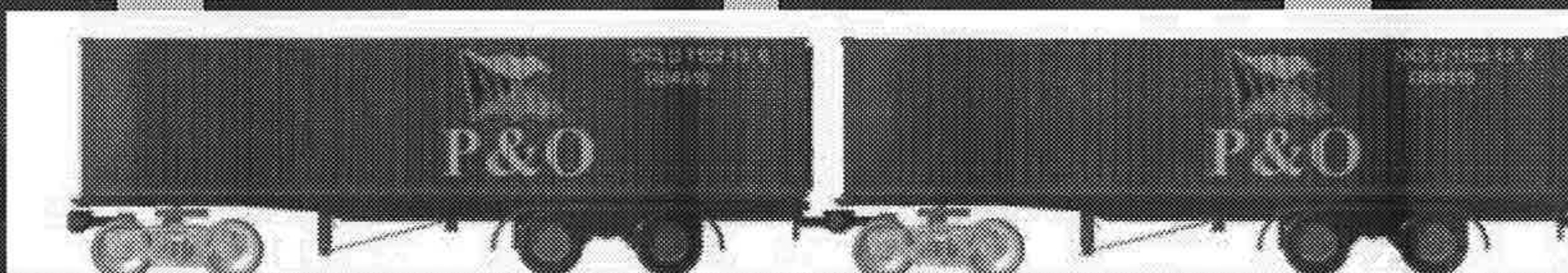


Transport standard rail cars



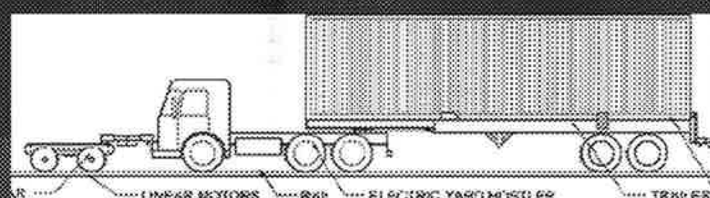


Transport standard truck trailers



Transport entire trucks

Transport trailer consists



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ELECTROMAGNETIC SYSTEMS

Proprietary Information

SCIG & ICTF Properties Route - Overview

LSM Railway Route Diagram Connecting Port of LB – Pier A Terminal with ICTF and SCIG near dock terminals.

- 5 miles each direction.
- 1 mil. containers on trucks taken off local roads resulting in zero emissions.
- 1.25 Mil. gal. of diesel fuel will be saved per year resulting in less reliance on imported fuel.

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Proprietary Information

Value Proposition / Public Health-Public Safety

- Reduction of energy costs as diesel fuel is twice as costly per energy unit than electricity from a stationary power plant.
- Reduces costs to move containers out of Long Beach/LA Ports making our ports more competitive nationally creating more jobs
- Reduction of pollution as diesel engines produce 120 to 240 times more particulate pollution and NOX than a stationary power plant.
- Reduction of costs to the public of lost time, wages and health resulting from the effects of pollution, thereby increasing public health benefits.
- Low installed cost , low operating and maintenance costs

Only 1 vehicle at a time on track section: No chance of collision

Calculation of Linear Motor Fuel Savings

- Operating assumptions
  - 10-mile route with 1 million cargo cars/year
  - 50 tons/car → 500 million ton-miles of traffic per year
- Diesel fuel cost (conventional locomotives)
  - 400 ton-miles/gallon fuel over 500 million miles = 1.25m gal/yr
  - 1.25 million gal/year x $2.30/gal = <u>$2.87M/year diesel fuel cost</u>
- Electricity cost (LIM/LSM)
  - 0.5 lb diesel/Hp-hr → 14 Hp-hr.gal → 10.6 kWhr/gal
  - 400 ton-miles/gal over 500 million miles = 13.3m kWhr
  - 13.3M kWhr x $0.12/kWhr = <u>$1.596M/year electricity cost</u>

Calculation of Linear Motor NOx Reduction

- Same operating assumptions (500 million ton-miles/year of traffic)
- NOx emissions (conventional locomotives)
  - 202 g NOx/gallon fuel x 1.25 m gal/yr = 252.5m g NOx/yr
  - 252.5M g NOx/year = 278 tons NOx/year
- NOx emissions (Linear Motor Rail)
  - 0.15 lb NOx/MWhr (2000 SCE power plant rule)
  - 0.15 lb NOx/MWhr x 13,300 MWhr/year = 1,995 lb NOx/year
  - 1,995 lb NOx/year = 1 ton NOx/year
- That's 278 Tons vs. 1 Ton over a single 10 mile stretch of rail

Market Potential

- **Freight**
  - Railroads
  - Trucks
  - Port terminals
  - Intermodal railyards
- **Passenger Rail**
  - Metro
  - Light Rail
  - Commuter Rail
- **Autos / Trucks / Buses**
  - Auto lanes
  - Truck lanes
  - Bus lanes

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LSM Drive Characteristics
Preliminary Analysis - The Virtual train

- Independent remote or on board control of each vehicle
- Magnetic propulsion and regenerative braking reduces energy cost by as much as 75% under certain operating conditions.
- Only one vehicle allowed per track section – collisions impossible.
- Reliable
  - No moving parts – Reduced maintenance, energy and operating costs.
- Force is applied directly to vehicle
  - Reduces wear on wheels and rails
  - High performance (acceleration, velocity)→ High Throughput
- Complete control over acceleration and velocity
- Quiet – no engine noise.
- Capital cost comparable to electric overhead conversion

Published To web.

Proprietary Information

Zero Emissions LSM Magnetic Propulsion on Standard Railway/Roadway Infrastructure

Presentation for GreenTech Forum
August 3-4, 2009
Pasadena Convention Center

A presentation by:

Innovative Transportation Systems Corp.
General Atomics Electromagnetic Systems Division
AECOM

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Proprietary Information

Innovative Transportation Systems Corp.
(ITSC)

Collaborated with General Atomics to determined feasibility of utilizing Linear electric motors that launch fighter aircraft from aircraft carriers and applying it to moving rail cars.

The catalyst for bringing General Atomics and AECOM together.

Some other affiliates of the Shapery Group of Companies, a major commercial real estate and technology developer.

- Shapery Gyronautics Corporation
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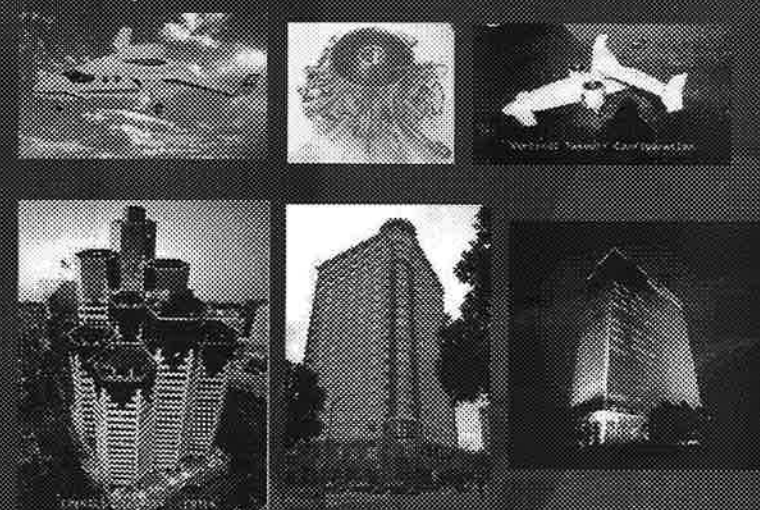

Headquarters in San Diego, CA

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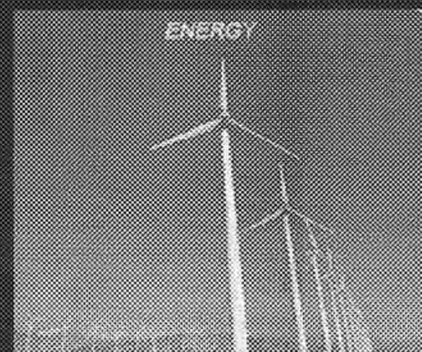
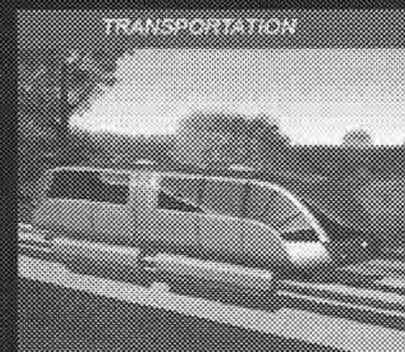
GENERAL ATOMICS ELECTROMAGNETIC SYSTEMS

Proprietary Information

General Atomics

- World's leader in high power linear motors.
- Founded 1955; Privately owned; 5,000 employees





UAV / Predator	Fusion	Linear Motor Transportation Maglev Systems
Advance Sensors	Fission Reactors	
Naval Ship Electrification	Uranium Mining	Streetcar Refurbishment
Electromagnetic Aircraft Launch	Algae Synfuels	Mining Truck

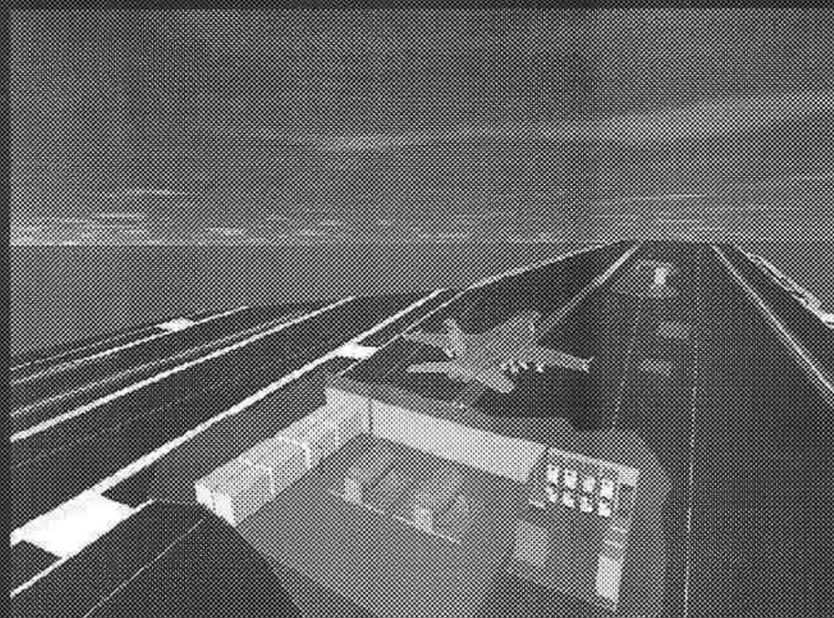
AECOM Corporation

- World's largest engineering and environmental company.
- Strong international experience to effect large transportation projects.
- Representing many Ports and Railroad projects worldwide.
- Designed Alameda Corridor.
- Headquarters in Los Angeles.

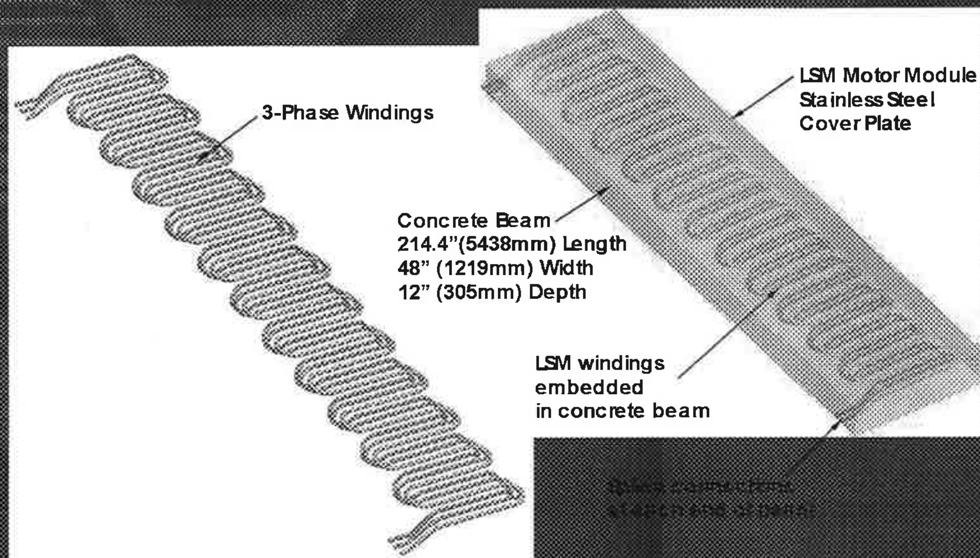
Background

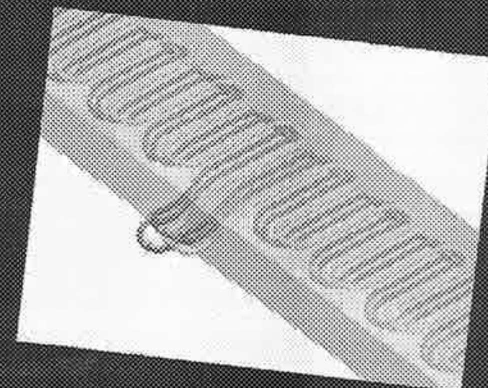
Collaborated with General Atomics to determined feasibility of utilizing Linear electric motors that launch fighter aircraft from aircraft carriers and applying it to moving rail cars.

The catalyst for bringing General Atomics and AECOM together.



Key Building Block is Linear Synchronous Motor (LSM):





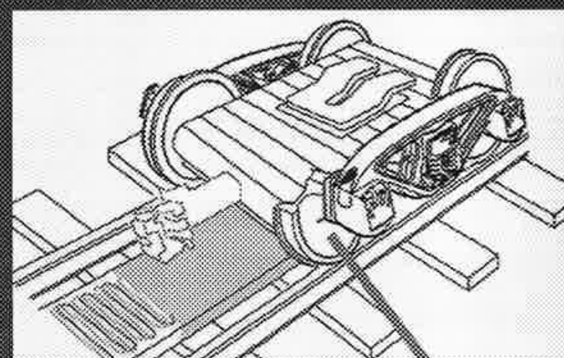
* Patent Pending

Wind LSM Cables → **Encase in Concrete/Composite** → **Join Modules**

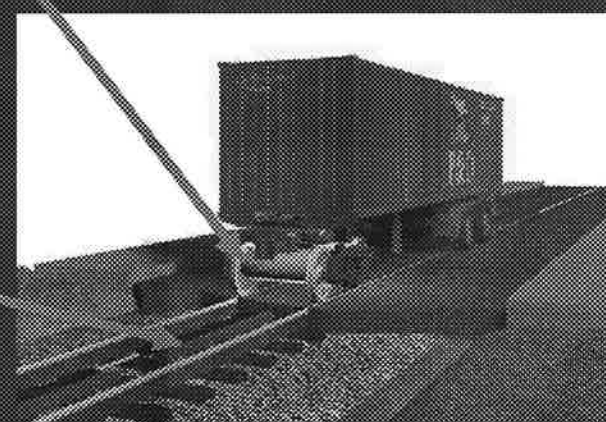
- Simple modular design – minimum impact during construction
- Efficient electric linear motor – minimizes operating costs
- No moving parts – minimizes maintenance costs

Proprietary Information

Using Existing Railway Infrastructure is a Lower Cost Solution



Linear motor embedded in middle of existing railway track



Magnetic rail bogey can be used to transport standard truck trailers

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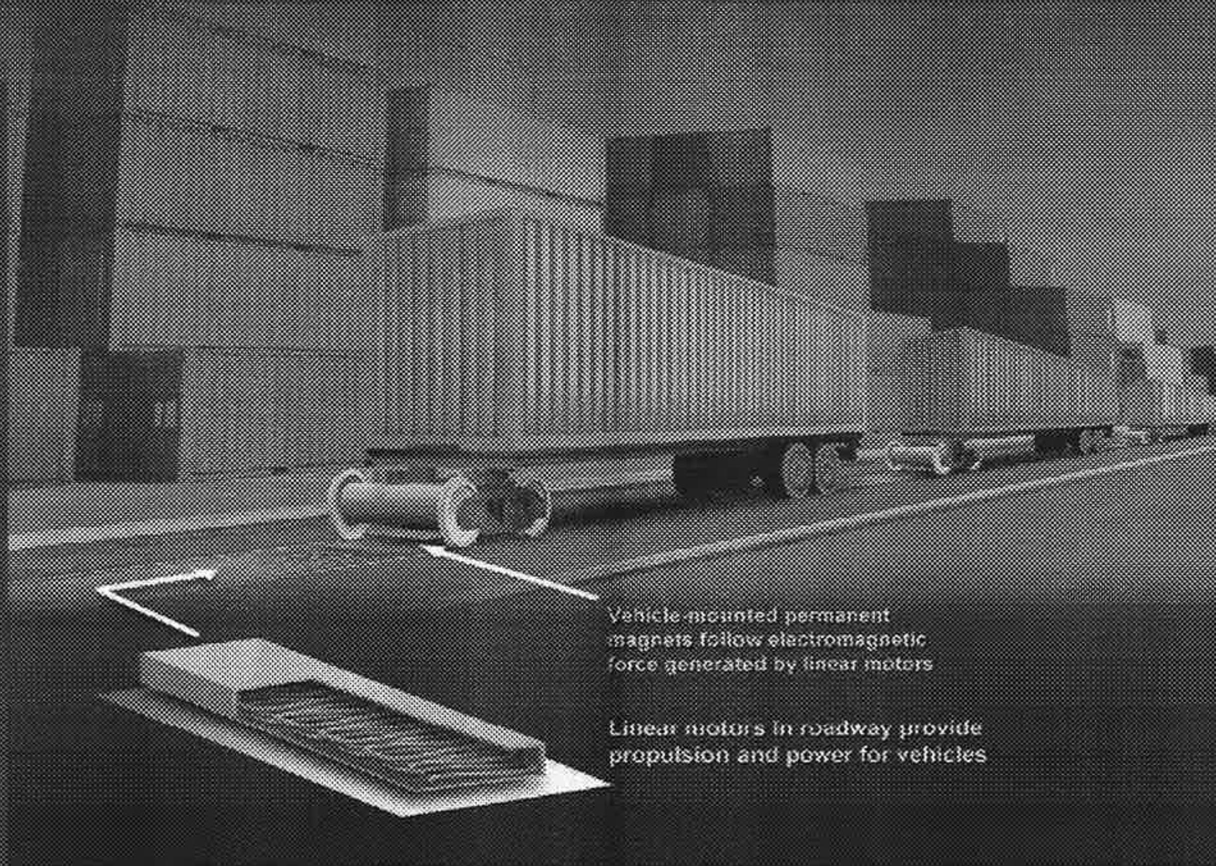
Proprietary Information

Zero Emissions Container Mover System for Transporting Container from On-dock Terminals to Inland Near-dock Terminals



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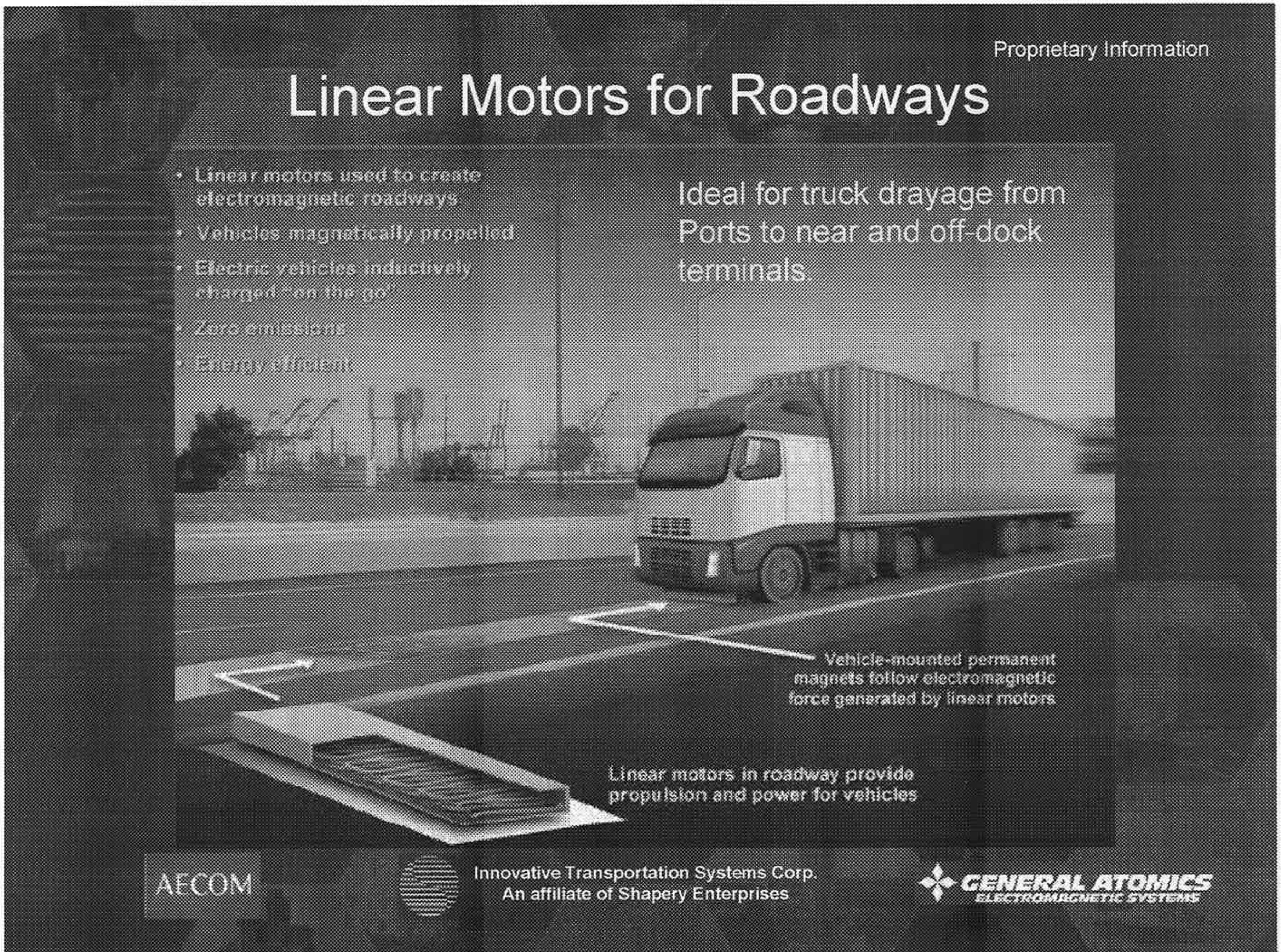
Proprietary Information
Linear Motors for Roadways
Linear motors used to create electromagnetic roadways
Vehicles magnetically propelled
Electric vehicles inductively charged "on the go"
Zero emissions
Energy efficient
Ideal for truck drayage from Ports to near and off-dock terminals
Vehicle-mounted permanent magnets follow electromagnetic force generated by linear motors
Linear motors in roadway provide propulsion and power for vehicles
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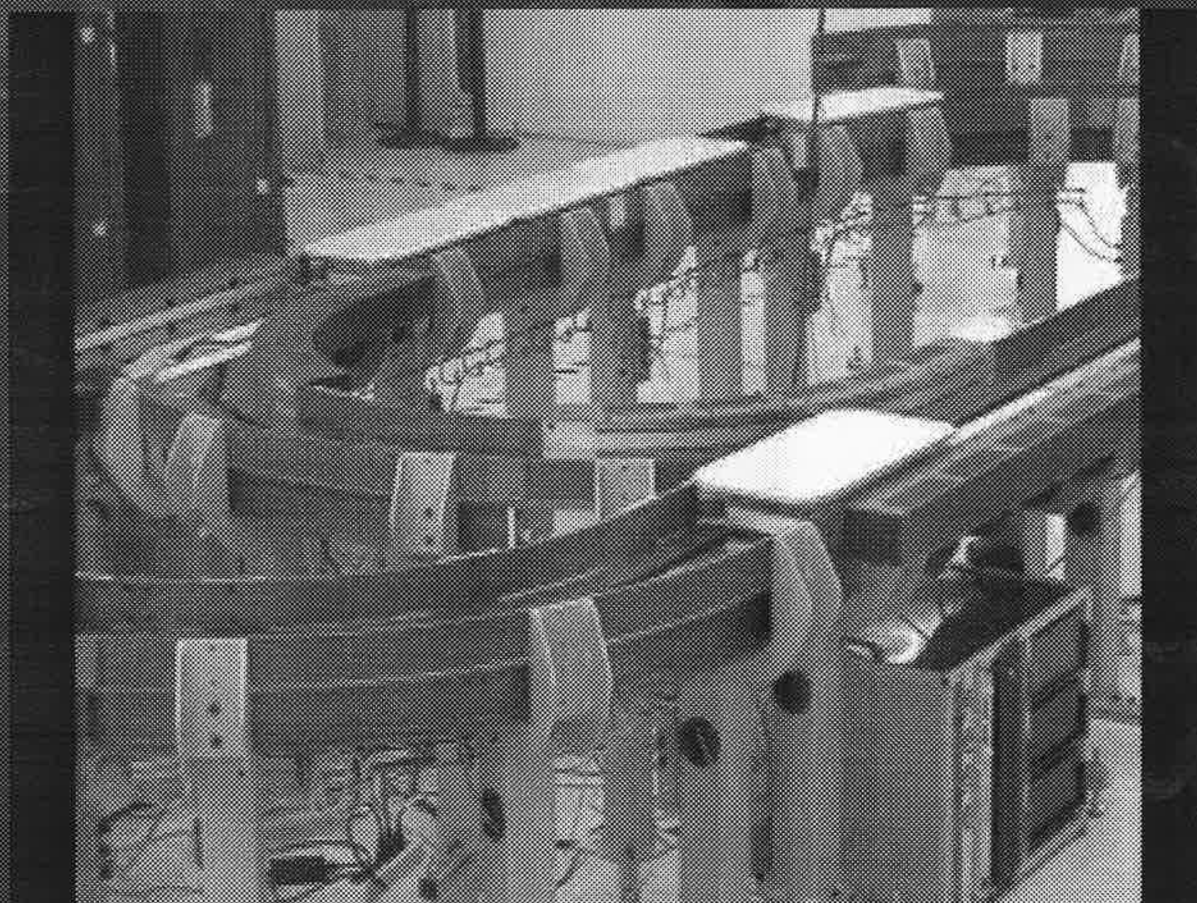
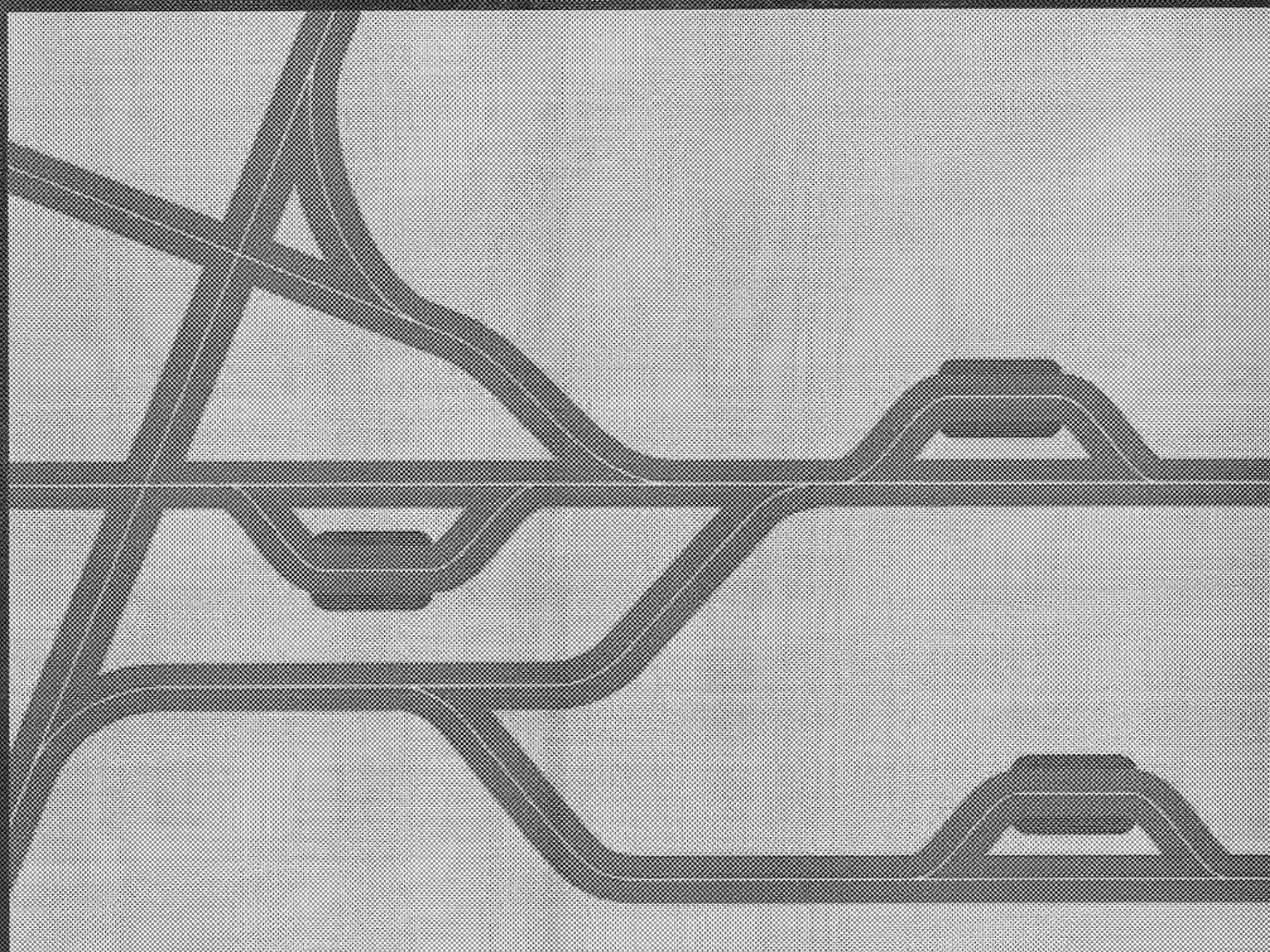
9

LSM adaptation from manufacturing



Video courtesy of MagneMotion Corp.

Virtual Train



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- Spiritual Inspiration
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- Dreams

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- Deeksha

Even more Wisdom
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- Spiritual Healing
- Womens Spirituality
- Yoga Positions

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Maglev Train

Maglev Train - Existing Maglev Systems - Encyclopedia II

Maglev Train - Birmingham 1984–1995. The world's first commercial automated system was a low-speed maglev shuttle that ran from the airport terminal of Birmingham International Airport (UK) to the nearby Birmingham International railway station from 1984 to 1995. The length of the track was 600 m, and trains "flew" at an altitude of 15 mm. It was in operation for nearly eleven years, but obsolescence problems with the electronic systems made it unreliable in its later years and it has now been replaced with a cable-drawn system. ...

Maglev Train, Maglev Train - Baltimore-Washington, Maglev Train - Berlin 1989-1991, Maglev Train - Berlin-Hamburg, Maglev Train - Birmingham 1984-1995, Maglev Train - Economics, Maglev Train - Existing Maglev Systems, Maglev Train - FTA's UMTD program, Maglev Train - Honolulu, Maglev Train - Inductrack, Maglev Train - JR-Maglev, Maglev Train - Linimo Nagoya East Hill Line, Maglev Train - London-Glasgow, Maglev Train - Munich, Maglev Train - Pittsburgh,

Maglev Train - Existing Maglev Systems

Maglev Train - Birmingham 1984–1995

The world's first commercial automated system was a low-speed maglev shuttle that ran from the airport terminal of Birmingham International Airport (UK) to the nearby Birmingham International railway station from 1984 to 1995. The length of the track was 600 m, and trains "flew" at an altitude of 15 mm. It was in operation for nearly eleven years, but obsolescence problems with the electronic systems made it unreliable in its later years and it has now been replaced with a cable-drawn system.

Maglev Train - Berlin 1989–1991

In West Berlin, the M-Bahn was built in the late 1980s. It was a driverless maglev system with a 1.6 km track connecting three stations. Testing in passenger traffic started in August 1989, and regular operation started in July 1991. Although the line largely followed a new elevated alignment, it terminated at the U-Bahn station Gleisdreieck, where it took over a platform that was then no longer in use; it was from a line that formerly ran to East Berlin. After the fall of the Berlin Wall, plans were set in motion to reconnect this line (today's U2). Deconstruction of the M-Bahn line began only two months after regular service began and was completed in February 1992.

Maglev Train - Transrapid

Transrapid, a German maglev company with a test track in Emsland, constructed the first operational high-speed conventional maglev railway in the world, the Shanghai Maglev Train from downtown Shanghai, China to the new Shanghai airport at Pudong. It was inaugurated in 2002. The highest speed achieved on the Shanghai track has been 501 km/h (311 mph), over a track length of 30 km. Transrapid uses EMS technology.

Maglev Train - JR-Maglev

Japan has a test track in Yamanashi prefecture where test trains JR-Maglev MLX01 have reached 581 km/h (363 mph), faster than wheeled trains. These trains use superconducting magnets which allow for a larger gap, and repulsive-type "Electro-Dynamic Suspension" (EDS). In comparison Transrapid uses conventional electromagnets and attractive-type "Electro-Magnetic Suspension" (EMS). These "Superconducting Maglev Shinkansen", developed by the Central Japan Railway Co. ("JR Central") and Kawasaki Heavy Industries, are currently the fastest trains in the world, achieving a record speed of 581 km/h on December 2, 2003.

Maglev Train - Linimo Nagoya East Hill Line

Financial News

Press Release Source: Port of Los Angeles

Updated Economic Impact Study Shows That Ports of Los Angeles, Long Beach and Alameda Corridor Remain Vital to U.S. Economy and International Trade

Thursday March 22, 11:50 am ET

Study Finds $256 Billion of Containerized Trade and Over 3.3 Million Jobs Nationwide Connected to the Ports of Los Angeles and Long Beach

LOS ANGELES--(BUSINESS WIRE)--A comprehensive trade impact study released today by the Alameda Corridor Transportation Authority (ACTA) and the San Pedro Bay ports of Los Angeles and Long Beach reinforces the agencies' critical role in international trade and the economic benefits Southern California's Pacific trade gateway provides to the entire nation. In particular, this detailed study reveals the economic benefits that exported and imported goods moving through the nation's two largest container ports and the Alameda Corridor have for every region across the country.

The San Pedro Bay ports handle more than 40% of the nation's total import traffic and 24% of its total exports. From the machinery, raw materials, cotton and other goods being shipped overseas to the clothing, toys, and other products coming into the country, thousands of exporters and importers across the country rely on these ports as their primary gateway for trade. Since 1994, when this trade impact study was first conducted, the growth in the national impact of trade for goods being transported the San Pedro Bay ports increased 246%, from $74 billion to $256 billion.

"Southern California is America's Gateway to the global economy and plays a central role in sustaining the nation's prosperity," said Los Angeles Mayor Antonio Villaraigosa. "As container traffic continues to grow, however, we must invest more in our goods movement infrastructure while addressing the environmental and health impacts of our ever-expanding international trade."

"The study re-affirms the national significance of the San Pedro Ports. These two ports lead the way not only in cargo volumes but in implementing forward-thinking environmental mitigation strategies that recognize the severe health impacts on our communities of such monumental commerce," said Long Beach Mayor Bob Foster.

The study also assessed the economic impact of the San Pedro Bay ports in terms of state and local tax revenues and full-time jobs created. State and local taxes generated throughout the nation from this trade activity grew from an estimated $6 billion in 1994 to more than $28 billion in 2005. The number of direct and indirect jobs associated with the trade activity generated by the San Pedro Bay ports increased by 200%, from 1.1 million jobs nationally in 1994 to 3.3 million jobs in 2005.

National Trade Activity Segmented by Region

In addition to assessing the national impacts of trade activity at the San Pedro Bay ports, the study also examined the economic value of this trade in various regions of the country. Of the $256 billion in total national trade activity, the regions which show the greatest reliance on Southern California's ports include: the Southwest region ($82 billion in imports and exports); the Great Lakes region ($53.7 billion); the Southeast region ($37.7 billion); and the South Central region ($27.3 billion). Similar analyses was conducted to determine the jobs associated with this trade in each region, with the Southwest (1,114,400 jobs), Great Lakes (681,800), Southeast (498,900), South Central (435,700), and Northwest (339,900) leading the way.

America's Goods Movement Corridor

As the first link in the national rail system leading out of the San Pedro Bay ports, the Alameda Corridor has seen 106% growth in cargo movement over the last four years; more than double that of the ports' growth during that time. More than 60% of the cargo which arrives at the San Pedro Bay ports is ultimately destined for markets outside of Southern California, and a large portion of that cargo is handled by the 20-mile Alameda Corridor. In 2006, the Alameda Corridor carried 19,924 trains, an average of 55 trains per day. This represents a 15% increase over the number of trains which used the Corridor in 2005. In addition, nearly 5 million Twenty-foot Equivalent Units (TEUs) were transported via the Corridor in 2006, a 32% increase from the 3.75 million TEUs moved on the Corridor in 2005. On an average day, the Alameda Corridor carries 14,000 TEUs of cargo, more than twice the entire daily volume of cargo that is handled by the Port of Oakland.

With more than $256 billion in containerized trade moving through the San Pedro Bay ports in 2005, this study illustrates the need for a continued federal and state commitment to supporting and improving Southern California's goods movement infrastructure network. The results of this latest economic study also serve to further demonstrate the critically important role that the Alameda Corridor plays in the national economy as the linchpin to the goods movement network.

The Port of Los Angeles, a non-taxpayer-supported department of the City of Los Angeles, and the Port of Long Beach, a non-taxpayer supported department of the City of Long Beach, are the top two container seaports in America. Together, the ports occupy about 7,400 acres of land, 7,900 acres of water and 78 miles of waterfront in Southern California. With about 60 (combined) terminals serving container, automobile, break bulk, liquid bulk and dry bulk customers, the ports facilitate the flow of goods that sustain the entire nation. In addition to leading the nation in international cargo trade, the San Pedro Bay Ports are dedicated to leading the world in progressive and aggressive environmental programs. In November 2006, at a first-ever joint meeting of the two Harbor Commission Boards, the San Pedro Bay Ports Clean Air Action Plan was adopted. This landmark plan, the first in maritime history, outlines a strategy for reducing air emissions at both ports by roughly 50 percent over a five year period.

(Editor's Note: For more information about the economic study, or to secure quotes from ACTA, Port and other elected and business leaders, please visit www.acta.org, www.polb.com, or www.portoflosangeles.org.)

Contact:

Port of Los Angeles
Theresa Adams Lopez, (310) 732-3093
or
Port of Long Beach
Art Wong, (562) 590-4121
or
Cerrell Associates (for ACTA)
Jeff Lustgarten, (323) 466-3445

Source: Port of Los Angeles

Posted on Tue, Nov. 28, 2006

LA-area ports to study magnetic levitation cargo train

Associated Press

LOS ANGELES - Harbor officials are planning to study whether magnetic levitation trains could be used to ferry cargo containers moving through the nation's largest port complex.

The so-called maglev trains are seen as a possible way to ease traffic congestion and cut down on air pollution near the Ports of Los Angeles and Long Beach.

Researchers at California State University, Long Beach, are studying three proposals for using maglev trains to move cargo.

The Southern California Association of Governments and officials at the two ports are planning to launch their own studies in coming months.

"If we are going to get serious about cleaning up the port, we need to bring electric power into the transportation system. We need to be emission-free if we are going to grow," said S. David Freeman, president of the Los Angeles Harbor Commission. "Maglev is one of several options we are looking at. It has a lot going for it."

Maglevs are propelled along magnetic fields generated by guide rails on the ground. They can reach speeds of up to 300 mph.

Two maglev train systems transporting passengers are operating in China and Japan.

No one has yet to adapt the maglevs to carry freight, however.

General Atomics in San Diego is developing a system for cargo containers.

Among the maglev projects being studied is a 4.7-mile system between the Port of Los Angeles and the proposed Southern California International Gateway, a rail terminal to the north.

Building the project would cost roughly $575 million and $9.2 million a year to operate.

A 100-mile maglev network linking inland cargo distribution centers to the ports is projected to cost around $8.5 billion.

Another maglev proposal under review involves a 20-mile line running by the Long Beach Freeway.

Information from: Los Angeles Times, http://www.latimes.com

Innovative Transportation Systems Corporation

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Administration

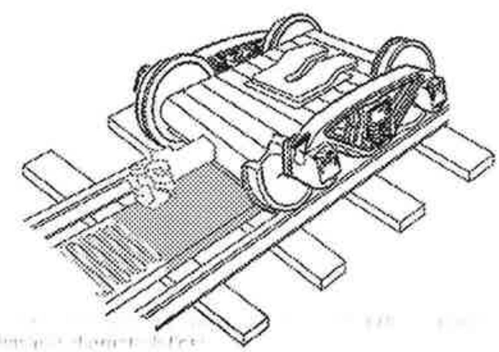
Port Container Moving System

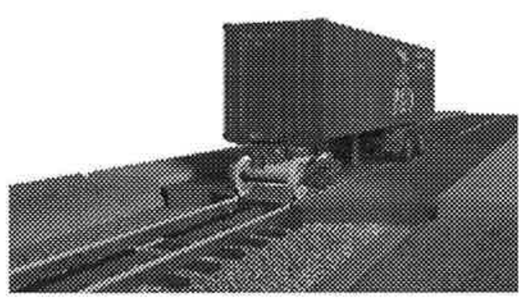
The Zero Emissions System

This system will have the following characteristics:

- *Independent remote or onboard control of each vehicle*
- *Magnetic propulsion and regenerative braking reduces energy consumption by as much as 75% under certain operating conditions* — NO EVIDENCE
- *Only one vehicle per track section -- collisions impossible* — hardly - it's the trailers
- *Reliable: No moving parts, reduced maintenance* — contrary to act exper.
- *Complete control over acceleration and velocity* — caveat
- *Quiet -- No engine noise* — also may true
- *Capital cost comparable to electric overhead conversion* — see spec

Freight transport by train is the most economical way to move large amounts of freight for long distances. However, the movement of massive amounts of goods through Ports using diesel locomotives is highly polluting and getting worse as freight train traffic has doubled in the last 35 years. The Environmental Protection Agency estimates that combined emissions from Diesel trains in Chicago, Los Angeles, Houston, Dallas, Baltimore and Detroit is equal to the emissions created by 55 million cars meeting today's automotive emission standards. This amounts to 37% of all automobiles driven in the United States today

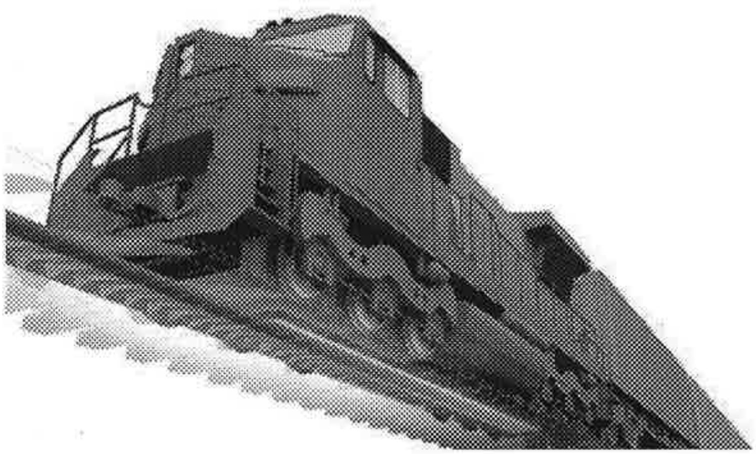




The goal of the Zero Emissions Port Container Moving System is to use linear motor rail conversion to develop the next step in the evolution of railcars to a near zero emissions electric propulsion system a lower energy and capital cost which is fully automated. It is estimated that this goods transport method will produce between 1/150 and 1/250 the amount of pollution as existing methods, at 1/3 the f cost.

By simply installing a diesel truck fifth whe on the top of the magnetically fitted bogey and paving the LSM track, similar to a street car operation in urb streets, the port container moving systems becomes a reality.

agreement to a Non-Disclosure Agreement with ITSC. All confidential information remains the property of ITSC and/or its Partners



MagneRail™ Linear Motor Technology

MagneRail™ is an innovative transportation concept based on the idea of retrofitting conventional steel-wheel rail lines with linear synchronous motors, most likely mounted to the railroad ties between the rails. By creating moving magnetic fields within the linear motors, rail cars could be propelled "passively" by mounting permanent magnets to the undercarriages of the vehicles. The force created by the track-mounted linear motor would react against the permanent magnets, forcing the vehicles to move in the direction of the moving magnetic field. In an early MagneRail™ concept, pictured above, existing locomotives would be retrofitted with permanent magnets, enabling them to pull rail cars on linear motor rail segments without using their diesel engines. More recent MagneRail™ concepts feature a specially-designed magnetic "power car" that would not use engines or any active onboard propulsion. Such a lightweight, rolling rail chassis equipped with permanent magnets would be optimized to operate on track equipped with linear motors, and would cost a fraction as much to build and operate as a conventional locomotive.

GA has entered into a Teaming Agreement with Innovative Transportation Systems Corp. (ITSC), a San Diego transportation project management firm, to develop and market MagneRail™ systems customized for a variety of applications, including:

- Goods movement – MagneRail™ power cars could tow cargo containers between ports and intermodal container transfer facilities.
- Commuter rail – MagneRail™ technology could be used to magnetically propel commuter trains and other light rail systems, either by retrofitting existing rail cars with magnets or by developing new passenger vehicles designed specifically to operate on linear motor rail segments using permanent magnets.
- Street cars – By embedding rails and the linear motors between the rails in flat pavement, street-cars using either steel wheels on rail or rubber tires could be propelled using MagneRail™ technology.

Features

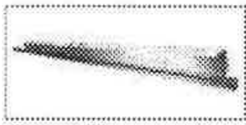
Linear Induction Motor

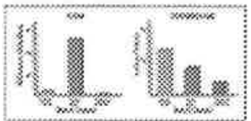
- Mounted to existing railroad tracks.
- Generates moving magnetic field that can be regulated to control vehicle acceleration and speed.
- Completely safe – sheathed in hard plastic and motor sections are energized only when trains pass over.
- No need for electrified third rails or overhead catenary lines

Vehicle

- Aluminum reaction plate mounted to underside of vehicle reacts against linear motor and moves vehicle forward.

- In lieu of the aluminum plate, an array of permanent magnets can be used, providing greater efficiency.
- Existing rail vehicles can be retrofitted, or new design vehicles can be built





Other Applications

- Light passenger rail.
- Commuter rail.
- Can be installed into specific sections of track, e.g., near passenger stations to reduce emissions and noise in populated areas.

GENERAL ATOMICS
ELECTROMAGNETIC SYSTEMS

Related News

2007

12/2007. John Quain, "Super Trains: Plans to Fix U.S. Rail Could End Road & Sky Gridlock," Popular Mechanics
With airports and highways more congested than ever, new steel-wheel and maglev lines that move millions in Europe and Japan have the potential to resurrect the age of American railroads.

11/4/2007. Peter Richmond, "A Better Way to Travel?", Parade.
Many transportation experts insist that the best answer to transportation gridlock is efficient intercity rail travel. Trains use one-fifth less energy than cars or planes. They run in bad weather. They're business-efficient and tourist-friendly.

9/21/2007. James Powell and Gordon Danby, "Maglev: Transport Mode for the 21st Century," EIR.
Maglev is a completely new mode of transport that will join the ship, the wheel, and the airplane as a mainstay in moving people and goods throughout the world. Maglev has unique advantages over these earlier modes of transport and will radically transform society and the world economy in the 21st Century. Compared to ships and wheeled vehicles—autos, trucks, and trains—it moves passengers and freight at much higher speed and lower cost, using less energy. Compared to airplanes, which travel at similar speeds, Maglev moves passengers and freight at much lower cost, and in much greater volume.

4/21/2007. Paterson, Stewart. "Maglev trains 'best option' for Edinburgh to Glasgow route," The Herald.
After considering more traditional options, a Strathclyde Partnership for Transport (SPT) study concluded that Maglev provided the most benefit for its cost for a high-speed link between Glasgow and Edinburgh, reducing travel time between Scotland's two largest cities to just 15 minutes.

4/21/2007. "Floating Rail Link," BBC News.
Councilor Alistair Watson says that the proposed Maglev link between Glasgow and Edinburgh could transform Scotland's economy.

4/14/2007. Leib, Jeffrey. "New Talk of Maglev Train," The Denver Post.
The Regional Transportation District's (RTD) decision to apply for partial privatization of the FasTracks commuter train projects in Denver brings the possibility for high-tech options such as the use of Maglev technology.

3/23/2007. "Shanghai Maglev Link to be Extended," Shanghai Daily.
Maglev line from Pudong International Airport to Longyang Road Metro Station in Shanghai will be extended to Hongqiao International Airport with hopes of being completed before the 2010 World Expo.

3/22/2007. "Updated Economic Impact Study Shows that Ports of Los Angeles, Long Beach, and Alameda Corridor Remain Vital to U.S. Economy and International Trade," Press Release by Port of LA.

3/22/2007. Smith, Ross. "Tyne to Tees a Breeze," The Journal.
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3/15/2007. Centers, Jessica. "Making Tracks," Westword.
The Rocky Mountain Rail Authority looks at the pros and cons of three different rail technologies to be implemented in the I-70 corridor.

2006

11/28/2006. Weikel, Dan. "Ports Considering Maglev Trains to Cut Smog," LA Times.
Port officials consider implementing maglev technology to transport freight in an effort to reduce smog and congestion.

11/24/2006. Curry, Jennifer. "Cal U Maglev Connector Plan may be Gaining More Momentum," Pittsburgh Business Times.
The current political situation gives maglev proponents hope that government funding could result in renewed interest in the proposed maglev connection between the two California University campuses in Pennsylvania.

11/2006. Smith, Timothy. "Study Looks at a Beaumont Maglev Distribution Center," Record Gazette.
Cal State Long Beach is conducting a study on a proposed maglev network connecting the LA and Long Beach ports to distribution centers in Beaumont, Victorville, and Los Angeles.

11/28/2006. "LA-Area Ports to Study Magnetic Levitation Cargo Train," LA Times.
General brief on the proposed LA and Long Beach Port applications of maglev for the movement of cargo.

11/17/2006. Hanson, Kristopher. "Engineers Tout Maglev at Ports," Long Beach Press Telegram.
Research shows that maglev technology seems a perfect fit as a solution to economic and environmental problems caused by the exhausted capacities of the current infrastructure.

2005 & Earlier

Summer 2005. Cooper, Hal. "42,000 miles of Electric Rail and Maglev," 21st Century.
An experienced railway consultant lays out the requirements and timetable for how to get from here to prosperity, via electrified rail

8/17/2004. Bigelow, Bruce. "A Train without the Daily Grind," Today at Berkeley.
Bigelow takes a thorough look at General Atomics' new passive maglev technology and its possible applications as well as the impeding obstacles to its success and implementation.

1/2004. Hall, Peter. "Speed," Metropolis Magazine.
Though Maglev is certainly the next big step in technology, Hall argues, the future of Maglev in the U.S. is blocked by administrative congestion and the want of awareness among government officials that leads to a lack of crucial funding to further develop Maglev project idling around the nation.

10/22/2002. Sharke, Paul. "Ticket to Ride," The American Society of Mechanical Engineering.
Sharke gives a detailed description of the test track in Germany, the track in China, and the proposed tracks in Southern California, Pittsburgh, and the Baltimore-Washington region. He also provides an overview of the differing GA passive maglev and Transrapid technologies in a speculative report on the readiness and willingness of Americans to adopt maglev transportation as an alternative to waiting and sitting in traffic.

3/7/1999. Grata, Joe. "Is Maglev in our Future?" Post-Gazette.
A special report on the many aspects of Maglev divided into the following sections: "Many hurdles before Maglev is able to get off the ground"; "How does it work? How long is it? These and other Q's and A's"; "What Maglev supporters are saying"; "Maglev vs. the airports people mover"; "California firm seeks to turn Maglev plan into reality"; "Maglev's $147 million budget"; "Oakland is 'the place,' in eyes of planners"; "Maglev: the profit motive"; "What Maglev costs so far; 22 firms supporting Maglev parking plan".

5/1998. Mangiat, Jeff. "Maglev Trains on Permanent Magnets," Popular Mechanics.
Permanent magnets in a Halbach array make passive maglev technology much more efficient to build and operate than previous Maglev systems have ever been

MAGLEV vs. TRAIN COMPARISONS

The traditional passenger rail industry and the Federal Railroad Administration shamelessly claim that steel-wheel-on-steel-rail mechanical train technology is superior to, or at least as good as, electronic non-contact maglev transport technology. NAMTI categorically denounces such false and transparent public relations efforts.

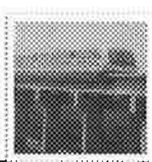
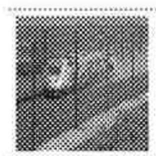
Maglev can be best characterized as electronic flight. Maglevs are not trains. Trains are trains and are highly maintenance intensive, unlike non-contact maglevs.

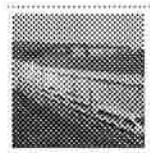
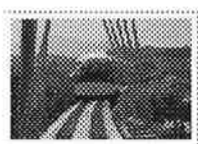
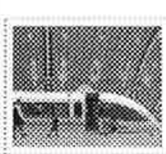
The videos in this section provide visual and audio proof to back up our position. As you will see, some of these comparisons are amusing or laughable.

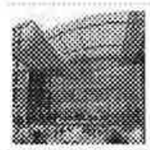
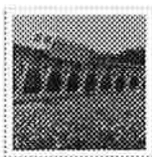
Building the best public transportation available is anything but funny because of its lasting impact on the nation's economy. That is why NAMTI is so intent upon educating the North American public about how their kids' future is being sold short by existing transportation policies and the efforts of passenger rail lobbyists.

We must tell our political representatives to upgrade or replace those federal and state agencies that doggedly hang onto old, maintenance intensive and subsidy-dependent mechanical transit systems that are clearly not economically sustainable.

Just click on the the thumbnail images below to see and hear the difference between these radically different technologies.

High-Speed Maglev	Low-Speed Maglev	Fast HMR	Slow HMR	Background For What
 **Transrapid TR-09 TVE Track, Lathen, Germany**  **Transrapid @ 267 mph Pudong Airport Connector, Shanghai, China**	 **HSST LInimo** Nagoya Japan No Vibration – Minimal Noise 6yrs no accidents Best it has complete grade separation	 **French TGV (*Train à Grande Vitesse*)**  **German ICE *(Intercity Express)***	 **Sound Transit Seattle, Washington, USA Noticeable Noise & Vibration**	**NOISE ALONG THE ROW** **The HSM and Fast HMR videos show vel (185mph) and are recorded from about t** **The Low-Speed maglev video is of the H which has a top speed of 60 mph (km/h)** **The Slow HMR video is of the Sound Tra Washington, USA.** **The noise differences are startling and c speed. Logical, when you consider that touching their guideways, while the stee contact vehicles have superior ride qual able to easily accelerate past the HMR tr faster speeds do introduce some vibrati passengers cannot move around the ca seats. No seat belts required, either.** **Judge for yourself what you see and he**
		see  **ICE Train Derailment @ 125 mph (201**	see  **Houston Light**	**SAFETY/ACCIDENTS, COLLATERA SEPARATION** **The German TR-08 maglev crash at arou ton maintenance cart was the world's de speed maglev accident.** **Date: September-2006** **Location: At the TVE maglev test facility region of Lower Saxony, Germany.** **Human Toll: 23 dead with 10 injured**

 TR-08 125 mph (201 km/h) Crash w/50 Ton Maintenance Cart Cause: Human Error	 HSST LInimo Nagoya Japan Completely Grade Separated – No Shared ROW Or Shared Track Results in 99.97% On Time – To The Second – Schedule Availability	km/h) Cause: Mechanical Failure/Metal Fatigue  ICE Train Derailment In Tunnel @ 125 mph (201 km/h) Near Fulda, Germany 26-April-2008 Cause: Sheep	Rail Line Video Show Why Grade Separation Should Be A Priority, Especially With Urban Systems. Besides Being Safer, Schedule Reliability Is Dramatically Improved, If Not Guaranteed With An Automated LSM System	Damage Report: Destroyed first carriage two carriages. Maintenance cart destroy damage to the guideway, the maglev did collateral damage. 2006 Cause: human error – controllers violate ops protocol The German ICE train crash at around 1: world's deadliest fast train accident. Dat Location: Near Eschede in the Celle dist Human toll: 101 dead with 88 injured. 6-3-'98 Damage Report: The entire train derailed and brought down a 300 ton road overp Cause: mechanical failure – a wheel rim separated The Low-Speed HMR video is from the c rail system – the music is perfect for the And, with the low-speed maglev, there is of the Nagoya system's complete grade doors, resulting in 6 years of near flawle What does it take for transit officials and systems are proven technology with low Hopefully, these videos will help them s
 Transrapid HSM Lathen, Germany All Maglevs Are Friction/Traction -Free & Run With Snow/Ice On Guideway – They Blast It Off As They Pass	 Rotem HSST Maglev Incheon Airport, Korea All Maglevs Are Friction/Traction -Free & Run With Snow/Ice On Guideway	 Fast HMR At Grade For Traction/Friction Based Propulsion To Work, Snow Must First Be Removed With Plows	 HMR Traction/Friction -based Propulsion Must Remove Snow/Ice From Tracks	**FOUL WEATHER OPERATIONS** The maglev video is of the Rotem LSM i also has a top speed of 60 mph (km/h). The HMR video is of a freight line's snow drift. The fact that all maglev systems sh places where it snows, there would be n
 TR-08 High-Speed				**NOISE LEVEL ARRIVING AT ST** See and hear the high-speed Shanghai r

Maglev Longyang Road Station Shanghai, China 19-Mile 2 station SMT Airport Connector	Linimo, Nagoya, Japan Arriving Very Quietly At Above Ground Station	 German Fast HMR ICE Trains Arriving & Leaving Frankfurt Station	 Light Rail Line Station Houston, Texas	Longyang Rd. Station on 9-NOV-2010. B background noise of a horn is from cars the maglev. The second video is of the slow-speed li station, noisy with signal bells ringing.
 Fast HSM German Designed Transrapid Vehicles Inspect Their Guideways With Each Passenger Trip So There Is No Need For A Separate Catenary & Track Inspection Geometry Vehicle	 LSM In Beijing Is Under Construction – This Is A Video Of It In Action – We Are Waiting On Information Regarding Guideway Inspection Procedures	 Fast HMR Dr. Yellow Track Inspection Train For Japanese Shinkansen System Checks Catenary & Track Geometry	 Slow HMR FRA Track Inspection Train For U.S. System Checks Track Geometry Only – There Is No Provision For Checking Catenary Because The U.S. Has So Few Electric Powered Rail Lines	<u>Track/Guideway Inspection Vel</u> Each mode has its own method of inspe its tracks/guideways. Notably, the HSM Transrapid system ne inspection vehicle since every maglev tr geometry information back to the centra center – the need for a specially designe eliminated.

A Perspective on Maglev Transit and Introduction of the PRT Maglev

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ABSTRACT

A critical review of maglev trains and convention wheeled trains was presented in an attempt to identify performance advantages of maglev. Traditionally claimed advantages of maglev were not found to hold up to wheeled train systems incorporating similar non-contacting propulsion; however, performance advantages were identified for velocities greater than 500 mph (805 km/hr). At these high velocities, travel at atmospheric pressure is not practical, and so, an analysis was made for applications in tubes of reduced pressures.

The feasibility of a personal rapid transit (PRT) system designed with maglev suspension and for travel in tubes of reduced pressure was evaluated. The PRT maglev would have superior service capabilities yet no obvious technological barriers. An economic comparison to maglev train systems suggested that the PRT maglev costs about 40% less while providing appeal to a broader audience. Proposed performance advantages of the PRT maglev include reduced energy consumption, reliance on electrical power, and significantly reduced transit times as compared to air or train systems. A practical approach to implementation is presented and consists of initially using lower velocities, higher tube pressures, and PRT vehicles connected as train units. Proposed evolution of the system includes attaining higher velocities and incorporating superconductive elements in the rail embodiments.

Key Words: Maglev, PRT, Train, High Speed, Vacuum

A REVIEW OF MAGLEV TECHNOLOGY

As noted by Sinha (1), it was only in the 1960's that fast electromechanical control gears and the advent of solid state electronics made maglev vehicles feasible. In 1958 Polgreen (2) filed for one of the first maglev patents on a maglev transit system based on repulsion between permanent magnets on the vehicle and along the guideway. Shortly thereafter, Silverman (3) filed for a patent based on attractive levitation using overhead rails and preferably electromagnets on the vehicle. These patents largely specify the genesis era of maglev transit during the late 1950's and early 1960's.

While systems could be conceived during the early 1960's, it was only in the later 1960's when technical issues such as stable suspension, low speed switching, and manageable rail tolerances made maglev transit a practical reality. Powell (4) led the way in truly feasible systems with the unprecedented introduction of (1) inductive suspension allowing vehicle-rail gaps in excess of three inches, (2) electrodynamic lateral stability, (3) incorporation of superconducting magnets, and (4) non-contact propulsion via jet engines. During this second, pragmatic era other significant advances were also made on switching (low speed) without moving parts (5, 6), linear induction motors which would allow the engine noise and fuel weight to be removed from the train (7, 8) and control methods for stable suspension (9, 10).

These and other advances led to several maglev demonstration projects (11) in the early 1980's. Throughout the 1980's attractive EMS suspension systems were advanced in Germany, and repulsive suspension (EDS) systems were advanced in Japan. During this same time period no significant projects were sponsored by the U. S. government. EDS system technology developed during this era is currently being offered for sale by the HSST Corporation of Japan .

The latest era of maglev transit in the United States is perhaps best described as the romantic era due to our governments romance with an idea of advanced transit over a cushion of air and without wheels. The funding made available in the early 1990's was politically motivated by a desire to regain superiority in this intriguing technology. The most significant production from this romantic era are the maglev system cost estimates reported in the Compendium of Executive Summaries from the Maglev System Concept Definition. Final Reports (12). While several U. S. markets consider implementing maglev train systems, no routes greater than a few miles appear to be in the near future.

MAGLEV SUSPENSION VERSUS WHEELED SUSPENSION

Cited advantages of maglev trains over wheeled trains (1, 12) include:

1) Wheels produce medium to high environmental noise levels.

RR inf @ low speed superior @ high speed

2) Wheeled systems rely on propulsion through wheel-rail friction, and the high aerodynamic drag forces lead to upper speed limits due to limited wheel-rail adhesion.

3) Maglev vehicles can accelerate and decelerate rapidly and bank steeply on curves.

4) Suspension through point contact (up to 70,000 psi or 482 MPa) leads to increased structural requirements and increased wear/maintenance.

5) Maglev trains have a certain romantic appeal.

Alternatively, advocates of wheel based trains justify high speed wheel based systems due to an already extensive rail network.

Already existing rail networks give merit to continuing with wheel based systems. However, as discussed subsequently, several cited advantages of maglev have a weak foundation.

While wheels are generally noisier than magnets, at high travel velocities aerodynamic noise greatly exceeds that from wheels (personal conversation with J. Harding, former director of U.S. Maglev Initiative, July, 1993). In perspective, minimal noise reductions are achieved by high speed maglev.

In a similar comparison of propulsion systems, linear synchronous motors (LSM) are capable of overcoming greater aerodynamic drag than wheels and have greater acceleration and deceleration capabilities than wheels. This non-contacting propulsion can be used with wheeled suspension and maglev systems alike. Combinations of LSM propulsion with wheeled suspension would provide needed propulsion without the expense of an entirely new rail system. The Detroit Metro already uses non-contacting linear induction motors (LIM) for propulsion (13, 14). Among its many advantages over conventional wheel propulsion are lighter weight vehicles, reduced height of train cars (15), and improved traction at all weather conditions, velocities, and grades. Figure 1 shows how the LSM propulsion system of the Magneplane concept (12) can be readily incorporated into the vehicles and tracks of a conventional train system. Cited advantages 2) and 3) are specific to LSM propulsion, not maglev suspension, and can be attained by wheeled and maglev systems alike.

An analysis of maintenance costs is simplified when making the assumption that maintenance costs are directly proportional to the weight of the vehicle. Such an assumption would be exact for a hypothetical system designed to have the exact same weight on all wheels, and where reductions in weight would result in eliminating some wheels.

For wheeled propulsion additional weight is advantageous to provide needed traction; however, lighter weight vehicles would be preferred with LSM propulsion. A 70% reduction is vehicle weight would be feasible (1) and would result in 70% reductions in maintenance costs. Furthermore, the application of high performance polymers and shock absorbers incorporating magnetic forces could further reduce maintenance costs.

Public perception be as it may, maglev trains will tend to have a romantic appeal. The romantic appeal and several successful demonstrations of maglev train systems make maglev trains a real alternative. However, for typical applications the slightly higher cost of maglev train systems and advantages of using exiting routes for wheeled alternatives have given the edge to wheeled systems.

In summary, maglev trains have limited advantages and significant disadvantages when compared to high speed wheeled trains using the latest non-contacting propulsion technology. To that end, the most advantageous applications of maglev appear not to be with conventional train systems. Alternatively, transit in low pressure environments and transit by personal rapid transit vehicles (PRT's) are two applications where maglev appears to have performance advantages.

USE OF PRT VEHICLES FOR INTERCITY TRAVEL

While in 1992 PRT concepts were considered dead, the funding of the PRT2000 (16) demonstration may revive the expectations of PRT systems (17). In particular, PRT systems would have advantages of 1) reducing traffic congestion through automation, 2) reducing travel time by providing service non-stop from origin to destination, 3) reducing travel time by having access to a continuous supply of vehicles rather than periodic, and 4) relying upon electrical energy.

Disadvantages (personal conversation with J. Perkowski, Bechtel, San Francisco, May, 1994) identified during the 1970's included 1) performance limitations of available control technology, 2) perceived high cost of the extra number of vehicles, 3) distasteful appearance inside cities, and 4) potentially poor ride quality due to routing problems. Of these disadvantages, advances in electronics since the 1970's should alleviate questions on control technology and mass production of smaller vehicles actually costs little more than the production of fewer large vehicles. In particular, modern RIM polymer technology has gone a long way in reducing costs for vehicles produced in lower quantities. Remaining disadvantages on appearance and routing are design specific.

Routing is made easier and more accommodating due to the small cross-sectional areas of the PRT tubes as illustrated by a comparison of the PRT structure to the Bechtel concept (12) structure. The over-under arrangement of Figure 2 could be made even more accommodating by separating the bi-directional tubes when necessary for routing. Single vehicle tubes of six feet diameters could actually go through buildings. The low pressure environment and maglev suspension reduce noise levels and make such routing practical. Tube walls could be designed similar to enclosed walkways presently used to connect buildings over busy streets in cities. Routing at grade and under highways would also help alleviate distasteful appearances. In addition, reduced pressures would allow smaller tubes to be used and these tubes would have greater routing flexibility. The use of maglev suspension would also further reduce vehicle maintenance costs. All-in-all, the combination of PRT with maglev is a good match.

A common concern with maglev for intra-city transit is the high magnetic drag at low velocities for EDS suspension. These problems could also be addressed by using control technologies that provide non-stop service to minimize low velocity travel and by incorporating magnets in rails at station locations. Non-stop service would also allow higher velocities to be effectively used and would improve system performance. Cruising velocities in excess of 100 mph (161 km/hr) would be practical within many cities due to 1) greater acceleration, 2) non-stop service, and 3) transit corridors of reduced pressure.

Finally, a PRT Maglev operating in tubes of reduced pressure would be practical for intracity and intercity service with the same system. PRT systems may not have previously be considered for routine inter-city service; however, reduced aerodynamic losses in low pressure tubes and dynamic formation of trains would alleviate disadvantages for this application. Intercity transit is perhaps the best application of PRT since it is during intercity transit that passengers spend hours awaiting the departure of jets or making connections. Proposed intercity service of SWISSMETRO (18, 19) would have transit times of 12 minutes between cities, innately eliminating advantages of larger train-size vehicles.

Figure 2 compares the guideway of a PRT maglev to that of SWISSMETRO and the Bechtel concept. For the PRT maglev, vehicular suspension structures are located in front of and behind the passenger cabin. A cost comparison is given in Table 1 (20).

TRANSIT IN TUNNELS AND AT REDUCED PRESSURES

Goddard (21, 22) first proposed transit (non-maglev) in evacuated tubes; however, it was not until the 1973 RAND study (23) detailed the synergism of maglev and low air resistance that high speed transit in evacuated tunnels became feasible. Development of these concepts continue with NASA's New Millenniums Concept (John Rather, NASA Headquarters) and with SwissMetro (18, 19, 24). Modifications to the base concept include using of gravity to store energy (25, 26) and extending the concept to personal rapid transit (PRT) (27, 20). The extension to PRT service can actually have a greater impact on transit time than higher velocities.

The 1973 RAND study led the course for maglev transit in evacuated tubes and identified all-encompassing technologies which were available in 1973. In fact, the greatest hurdle to implementation was identified as tunneling technology, or rather, tunneling costs.

Suppes (20, 27) directly addressed these tunneling costs by identifying methods for reducing tunnel diameters, reducing the number of necessary tunnels, and allowing above-ground tubes. Both reduced tunneling costs and at-grade routing were made possible by using smaller vehicles which could travel is smaller tubes. Figures 2 and 3 illustrate the vehicle and tube sizes for the PRT maglev. As detailed in Table 1, these PRT tubes would actually cost less than high speed train routes.

SWISSMETRO uses two tunnels connecting the stations (see Figure 2), and the tunneling costs represent about 75% of the capital costs. The PRT maglev could offer bidirectional service in one tunnel (see Figure 2). Eliminating one tunnel would reduce the SWISSMETRO cost by about 37.5%.

Initially proposed tunnel pressures for SWISSMETRO and the PRT maglev are similar to those surrounding supersonic aircraft at cruising altitudes, and similar to aircraft, the passenger compartments would be pressurized to maintain passenger comfort. By using pressures ranging from about 0.01 to 0.1 atm, SWISSMETRO would use smaller diameter tunnels to reduce capital costs while simultaneously reducing the energy consumed by the trains. Key advantages of SWISSMETRO to the Swiss public are reduced energy consumption and reduced environmental impacts due to smaller tunnels.

Upon first consideration, the concept of travel in low pressure environments can be rather distressful; however, low pressure travel environments are routinely used by passenger aircraft. While on earth's surface our body is accustomed to pressure of 1 atm (101 kPa), at typical passenger jet cruising altitude of 30,000-40,000 ft (9000-12000 m), the pressure ranges from 0.30-0.20 atm (30-20 kPa). In aircraft, scoops and compressors gather air to maintain pressure in the passenger cabin. Similar methods would be used for SWISSMETRO and the PRT maglev. It would be prudent to design initial PRT Maglevs to operate at the lower pressures (0.2 atm) presently used by commercial aircraft so as to minimize initial development needs. Optimal pressures for low pressure applications would depend on travel velocity and would vary from approximately 0.2 atm (20 kPa) to approximately 0.001 atm (0.1 kPa).

ENERGY CONSUMPTION

Aerodynamic Drag

The upper curve of Figure 4 estimates (does not account for trans-sonic and super-sonic variations in drag) a constant aerodynamic drag and shows how pressure can be reduced to compensate for otherwise increased drag at higher velocities. Optimal pressures depend upon many factors including the dynamic use of train units, the use of aerodynamic designs, tube diameters, and technology on propulsion systems. The walls of the tube would increase drag, and for purposes of this paper the walls are assumed to double the aerodynamic drag. To streamline the PRT Maglev trains, the lower vehicle design of Figure 3 would be preferred.

To calculate the drag (R_c) of a train of length L and perimeter P_c, A.I. Totten (28) has proposed Equation 1:

$$R_c = \left[0.0020 \; P_c \left(\frac{L}{100}\right)^{0.8} + K \right] V_x^2 \quad (1)$$

Equation 1 accounts for formation of train units. Wall effects were incorporated into equation 1 by multiplying Ra by a factor of 2 and air density is taken into account by multiplying by a further factor equal to the tunnel pressure in atmospheres pressure.

To minimize systematic errors, calculations using equation 1 were made relative to the Bechtel concept. The perimeter of a train is assumed to be approximately 2.7 times greater than that of the PRT Maglev, and the length of the PRT Maglev train is a factor of two greater due to only having three passengers seated across rather than six (only five are pictured; however, the Bechtel concept proposes six seats across) as with the Bechtel concept. Another 50% increase in length is added to accommodate improved comfort and PRT vehicle constraints. In total, a PRT Maglev train would have an average length approximately three times greater than a train accommodating the same number of passengers.

Based on this analysis summarized in Table 2 , at 300 mph (482 km/hr) and 0.2 atm (20 kPa) of pressure, the PRT Maglev would have 63% less aerodynamic drag than a 300 mph (482 km/hr) train operated at atmospheric pressure. Using similar calculations at 500 mph (805) and 0.05 atm (5 kPa), the PRT Maglev would consume 75% less energy than to train to overcome aerodynamic drag. To reduce greenhouse gas emissions, combinations of low pressure and velocity could be used to reduce energy consumption to 50%, 20%, 10% . . . of the energy consumed by the best available alternatives.

Magnetic Drag

For electrodynamic suspension, magnetic drag losses are proportional to the weight of the vehicle and are inversely proportional to travel velocity. The generally accepted form of the drag equation is given by equations 2 and 3 for high velocities. Here Fy is the vehicle weight, n is the total number of coils in magnets, I is the current in each coil, h is the height of levitation, t is the thickness of the conductive track, and s is the conductivity of the track.

$$F_y \propto \frac{nI^2}{h} \quad (2)$$

$$F_x \propto \frac{-1}{k\,t\,v_x} \quad F_y \propto \frac{-nI^2}{k\,t\,h\,v_x} \quad (3)$$

where

F_y = vehicle weight
n = total no. of coils in magnets
I = current in each coil
h = height of levitation
t = thickness of conductive track, and
k = conductivity of track

For the Bechtel 64 Mg maglev train traveling at a velocity of 300 mph (483 km/hr), the magnetic drag energy consumption is estimated at 0.64 MW while the aerodynamic drag energy consumption is estimated at 5.4 MW. Aerodynamic drag dominates the energy consumption for both the Bechtel concept and the present PRT Maglev concept operating at 0.2 atm (20 kPa). At 500 mph (805 km/hr) and approximately 0.03 atm (3 kPa), magnetic and aerodynamic drag would be approximately equal, and at less than 500 mph (805 km/hr) and 0.01 atm (1 kPa) the presence of magnetic drag significantly diminishes advantages of lower tube pressures.

Analysis such as this can be used to define feasible pressure versus velocity profiles such as that shaded in Figure 4. Figure 4 is specific to the PRT Maglev. Larger vehicles, lower magnetic drags, and different vehicle-tube clearances would change the window of opportunity.

System Evacuation

Comparison to Train Systems

Energy consumption for tube evacuation would originate from the three needs of 1) periodic "total" tube evacuation, 2) evacuation associated with vehicle/passenger entry and departure, and 3) air leaks of the tube system. Of these, further information is needed to evaluate the impact of air leaks. In practice the cost of leaks would justify use and development of advanced leak detection methods and coatings which would bring leaks under control.

The cost of total tube evacuation would be incurred periodically when the tube is exposed to atmospheric pressure for maintenance or for emergency procedures (e.g., emergency evacuation by flooding the tubes with air and having passengers walk to a tube exit). Standard adiabatic compression calculations were used to estimate the compression energy. Compression was modeled as a dynamic process with tube pressure decreasing as evacuation progressed.

For four tube evacuations per year, a compression efficiency of 80%, and a tube length of 800 km; 3.6, 5.6, 8.4, and 9.2 million MJ are required to remove 16 Gg of air and produce a pressure of 0.2, 0.1, 0.01, and 0.001 atm respectively. As listed in Table 3, this translates to 360-920 J per passenger mile or < $0.00002 per passenger mile. A similar calculation for the evacuation of the volume of a vehicle exterior for entry of a vehicle into the tube equates to < $0.0001 per passenger mile.

While periodic tube evacuations and vehicle entries have evacuation costs which level out at lower pressures, compression costs associated with continuous removal of air (from leaks) increase rapidly with lower internal pressures. At pressures less than 0.02 atm (2 kPa), these compression costs could become significant. Insufficient data is available to make estimates on these costs.

Comparison with Air Travel

In addition to comparing evacuation costs of the PRT Maglev to train system costs, these evacuation costs should also be compared to corresponding costs for air travel. For air travel, energy is expended to overcome earths gravity to achieve higher altitudes where lower pressures are available. At a mass of 500 kg per seat and a cruising altitude of 12,200 m (40,000 ft), 59.8 MJ of energy are consumed in overcoming gravitational forces. This compares to approximately 2.5 MJ of evacuation energy per passenger. Considering other factors such as energy for aircraft takeoff and the initial and final travel at atmospheric pressure by the aircraft, over forty times more energy is consumed to transport a passenger to low pressures by an aircraft than would be needed to maintain/enter low pressures in PRT Maglev tubes on earths surface for travel.

DISCUSSION OF RESULTS

System Costs

The cost estimates of Table 1 include both capital and energy consumption costs. A basis of 10 million roundtrips per year (3,500 passengers per hour per direction for eight hours per day for 365 days in a year) was used to allow capital and energy consumption costs to be compared.

Energy consumption is based on Bechtel's (12) oneway trip energy consumption of 19,000 kWh for a 497 mile (800 km) trip. (The 19,000 kWh is from Table A-3 of reference 12 and is based on the total trip and not just cruising velocities.) At 60% occupancy, 120 seats per vehicle, and $0.08 per kWh; the electrical energy costs $42.2 per passenger roundtrip or $0.85 million per year per mile of bidirectional track. As detailed in Table 2 , the 0.2 atm 300 mph PRT maglev has about 37% of the aerodynamic drag of Bechtel's concept or about $0.38 million per year per mile of bidirectional track with similar magnetic drags. These costs as well as vacuum and magnetic drag costs are also summarized by Table 3.

Capital costs are based on a direct comparison to Bechtel's reduced first cost estimate (12) which uses a higher cost for electrical power ($0.08 per kWh versus $0.055) with the advantage that local electrical companies would construct and manage guideway electrification facilities. Cost reductions in the PRT maglev capital reside in 1) reduced structure costs, 2) reduced propulsion costs, 3) reduced costs for stations and parking, and 4) reduced vehicle costs.

A 40% reduction in structure costs is based on a less expensive combined structure illustrated by Figure 2 . A further 25% reduction (12) is based on at-grade construction which is feasible due to a smaller cross section of the PRT maglev route.

Reduce propulsion system costs are claimed due to a 55% reduction in the combined aerodynamic and magnet drag of the PRT maglev as well as the use of a train unit which is three times longer for the PRT maglev. In total, the cruising propulsion requirements of the PRT maglev are only 15% of those of Bechtel's concept on a thrust per length of guideway basis.

Reduced station costs are associated with the smaller size of stations and incorporation with local metro service. Reduced vehicle costs are based on RIM production methods and shorter transit times leading to a need for fewer seats.

As a final comparison of costs and energy consumption, Table 3 compares the present calculations to those calculated in the analysis of a Canadian maglev system (1) as well as the Bechtel concept. The largest contribution to transit costs with maglev trains is the interest on capital and the second largest expense is that for electrical power. Costs to produce a tube pressure of 0.2 atm are negligible. A cost estimate including interest and energy costs amounts to a mere $0.059 per mile of travel.

The advantages of train systems in comparison to air travel can be readily seen. The savings in energy between the 300 mph, 0.2 atm PRT Maglev (483 km/hr, 20 kPa) and a B757 translate to about 264 Wh/seat-km or about $0.013 per mile of track at an energy cost of $0.03/kWh.

Comparison of Performance with Air Travel

An initial PRT Maglev system operating at 300 mph and 0.2 atm (483 km/hr and 20 kPa) would be faster and more convenient than any other land based transportation system; however, air travel would have advantages at greater distances. To calculate the point at which air travel would have reduced transit times as compared to the PRT Maglev, certain assumptions must be made on the transit to airports, wait before departure, layovers, and wait after arrival. Table 4 lists the assumptions used for a comparative analysis. The source of the data includes published sources (29), airlines (recommendations on when to arrive at airport before departure), and personal experience.

The basic difference between the two air transit scenarios is that Air 1 is a direct flight and Air 2 includes a layover. The basic difference between the PRT Maglev scenarios is that PRT A operates at a maximum velocity of 300 mph (483 km/hr) and PRT B operates at a maximum velocity of 500 mph (805 km/hr). Both PRT Maglev systems assume access from several locations within both cities and therefore have the average 10 minute transit time to the station.

As illustrated by the data of Table 4, a PRT Maglev with a maximum velocity of 300 mph (483 km/hr) would have shorter transit times than air travel at distances less than 907 miles (1460 km). With a maximum travel velocity of 450 mph (724 km/hr), the PRT Maglev would have shorter travel times for all travel within the continental United States. Based on these results, initial PRT Maglev systems having a maximum travel velocity of 300 mph would be the best available alternative for destinations up to 907 miles distant. A later increase in velocity to 500 mph lead to service better than any alternative in the continental United States.

Transportation Network

The PRT Maglev system could become a transportation network similar to our present highway system based on our interstate highway network. Local metro PRT Maglev tubes would be connected to interstate tubes, and each section would have a speed limit (speed set-point) for normal operation. Propulsion power would be supplied by linear motors along the tracks. Auxiliary propulsion from the vehicle would allow deviation from the speed set-point to allow the dynamic formation of trains to accommodate entering and exiting traffic. As high temperature superconductivity becomes reality, electric powered cars could be manufactured with magnetic suspension systems located within the four quarter-panels and, similar to HOV lanes, wheeled vehicles could literally drive onto and into a maglev transit corridor where automated maglev suspension would take over for much of the trip.

Local metro service could provide much needed pollution-free service to our cities. For cities, typical maximum upper speed set-points would initially be approximately 100 mph (161 km/hr). Depending upon the distance of travel, service could be in low pressure tubes or open to the atmosphere. The interstate network would be connected to local metro lines, and for the interstate network initial upper speed set-points would be approximately 300 mph (483 km/hr) with later speed set-points up to 3,000 mph (4,830 km/hr).

The combined network of local, intercity, and even transcontinental routes would provide

PRT service from a location close to travel origination to a location close to the final destination, and travel in low pressure environments makes very fast travel possible and minimizes environmental impact. Service would readily evolve to operation similar to an elevators where no advanced reservation is necessary and where railway stations are replaced with elevator entrances at multiple locations within cities. The high energy efficiency, low maintenance (due to very few moving parts and isolation from environment), and comparatively low capital costs would allow PRT Maglevs to cost less other modes of transportation. Lastly, reliance on electrical power allows ecological impact and cost to improve with new technology on electrical power generation.

Areas for Advancement

The PRT Maglev concept is new, and as such, many opportunities exist to improve.

One important area already emphasized is associated with operation at reduced pressures. It would be advantageous to operate initial systems at 0.2 atm (20 kPa) since this is an established standard for commercial aircraft, equipment is available, and the public has already accepted transit with vehicle exteriors at these pressures. Advancing to travel at increasingly low pressures leads to increased velocities, reduced energy consumption, and reduced travel times.

Improved tunneling, structures, and routing methods could reduce costs by reducing the guideway structural costs. Much could be gained from a concentrated research and development effort in this area.

Additional advantages could be realized by reducing the vehicle weight. Weight reductions should be able to match the specific weights for an automobile (300 kg per seat). Reduced vehicle weight leads to reduced forces on guideways and reduced magnetic drag.

An additional area for advancement would be the incorporation of superconducting rails for repulsive levitation. The NMI study (12) lists magnetic drag as ranging from 6 to 40 kW/ton for conventional conductors. Superconducting rails would reduce these values many fold and allow lower pressures to be used to reduce energy consumption costs to approximately one dollar for a 1600 km roundtrip. Such advances would make parcel service (30) of all sized packages feasible with maglev. Automated transit during off-hours could ship such freight with minimal increased capital and significantly increased profits. Without superconducting rails, freight could be shipped at costs of approximately $0.000023 per kg per mile during off-peak (11:00 PM to 6:00 AM) hours at lower velocities of approximately 200 mph.

CONCLUSIONS

Compared to 300 mph (483 km/hr) maglev trains, a 300 mph, 0.2 atm (20 kPa) PRT

Maglev would require approximately 56% of the infrastructure cost at $10 million per mile as compared to $17.9 million per mile of bi-directional guideway. The energy requirements of the 300 mph Maglev would be approximately 45% of that corresponding to a train system. Such a 300 mph, 0.2 atm PRT Maglev would operate at low pressures typically encountered by commercial aircraft and no new developments or breakthroughs would be needed for maintaining cabin pressure.

A similar PRT Maglev system at 500 mph (805 km/hr) would offer a 25% reduction in travel time due to higher velocities and even further time reductions due to PRT service. However, a 500 mph, 0.2 atm PRT Maglev would consume a similar amount of energy as the 300 mph Bechtel concept and would have similar system costs. On option for alleviating the higher costs at 500 mph is to reduce internal tube pressures to between 0.03 atm and 0.1 atm (3-10 kPa). Both increasing velocities to 500 mph and decreasing pressures to 0.05 atm could be performed as evolutions to an initial system operated at 300 mph and 0.2 atm.

The proposed PRT maglev is similar to SWISSMETRO which is currently being developed in Europe; however, the PRT maglev would require 37.5% less capital in the form of tunneling costs. In addition, many US routes would have preferred routing at-grade rather than in underground tunnels. At-grade routing would reduce costs but may limit travel velocities. For the present purposes, acceleration and comfort considerations were defaulted to be those used by the NMI studies (12).

Based on the results of this preliminary study, a PRT maglev designed with a cruising velocity of 300 mph in tubes at 0.2 atm would be faster than present alternatives up to distances of 907 miles (1460 km). In addition, the energy to maintain tube vacuum is greater than forty times less than the energy needed to attain altitudes of similar low pressure. This PRT maglev would be able to evolve such that lower tube pressures and increased velocities would allow the PRT Maglev to have reduced travel times for all travel routes viable with surface routing. A mature system would include velocities up to 3,000 mph (4,830 km/hr) and connections between Asia and America.

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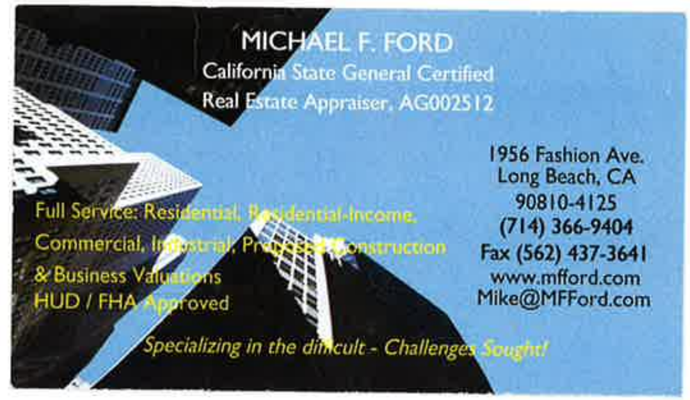
HOME

Last modified: August 18, 2002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Attachments from Comment Letter 91

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November 8, 2011

Mr. Bruce White
Three Rivers Trucking, Inc.
Post Office Box 160
Exeter, CA 93221-0160

SUBJECT: Three Rivers Trucking Facility
Long Beach-Hinson 220KV Transmission Line Right of Way
South of Willow Street, City of Long Beach
Contract Nos. 9000000002241 and 9000000001472

Dear Mr. White,

Thank you for meeting with Christine Fanous and me on Thursday, November 3, 2011 and for your letter providing a conceptual outline for a proposed reduced footprint along with pertinent information about Three Rivers Trucking ("Three Rivers"), a description of your current operations, and your inquiry to find a future solution to Three Rivers operations which appear to be impacted by the Burlington Northern Santa Fe ("BNSF") Southern California International Gateway (SCIG) proposed yard tracks within the Southern California Edison ("SCE") Transmission Line Right of Way located south of Willow Street, in the City of Long Beach.

As you may know, SCE has received a request from BNSF to relocate existing SCE facilities and for the acquisition of an easement to accommodate the BNSF SCIG yard tracks within the SCE Right of Way. The SCIG conceptual design showing the approximate track footprint within the SCE Right of Way indicates that the BNSF project appears to impact the dock, office, and maintenance buildings.

As we discussed, SCE reviewed your request for SCE to relocate the impacted buildings at other locations within the SCE Right of Way. SCE's Land Use Policy however only allows for low intensity uses on our Right of Way and does not allow permanent structures. Therefore, you were informed that SCE must deny your proposal for SCE to replace the impacted existing building by constructing new buildings at other locations within the SCE Right of Way.

As we also discussed, SCE may consider allowing Three Rivers to license the remaining SCE Right of Way, after the proposed easement acquisition for the BNSF project, for parking purposes only, but no structures.

If you have any questions regarding the above, please email me at Roslyn.Delmar@sce.com or call me at (626) 302-4120.

Sincerely,

Roslyn Delmar

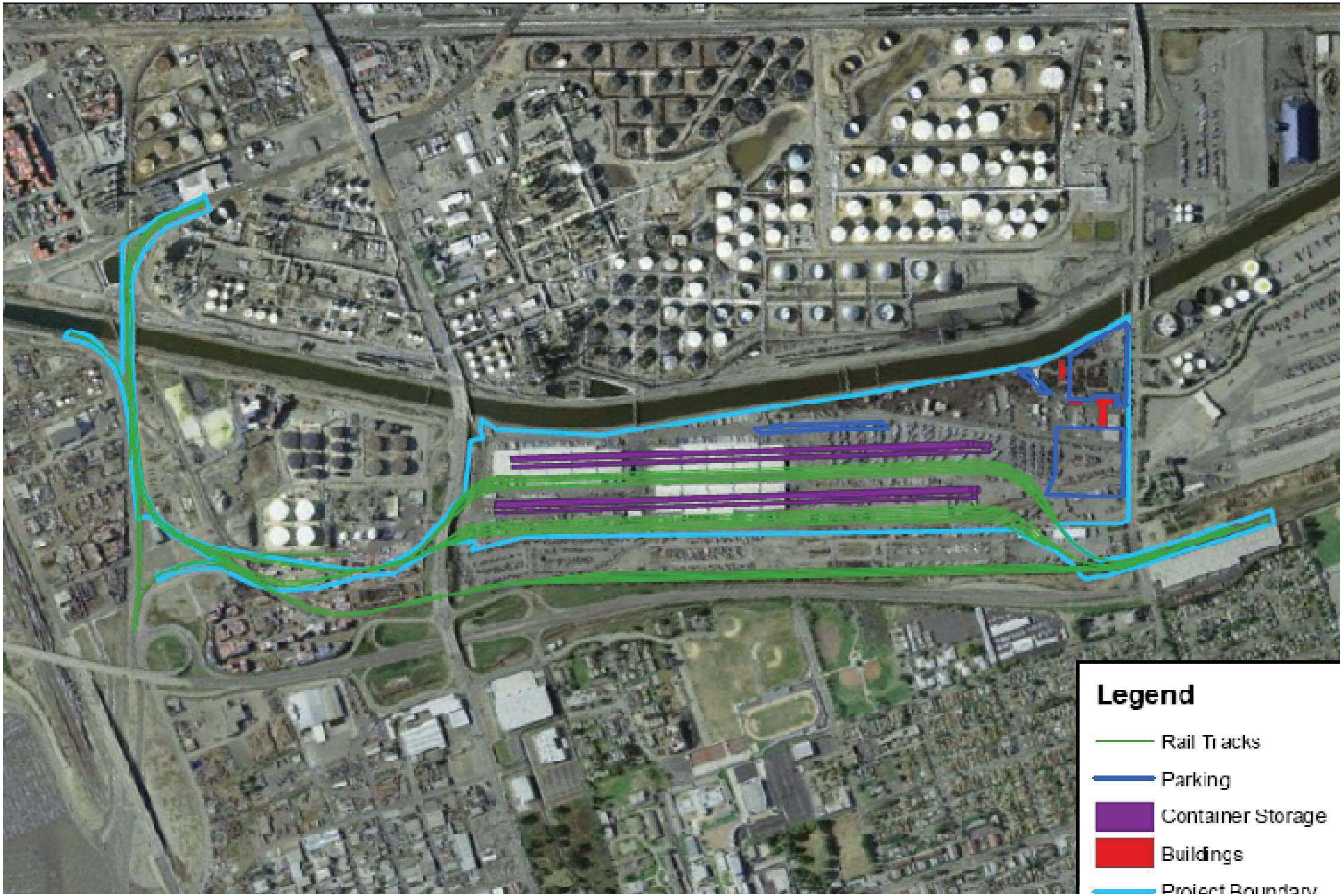
ROSLYN DELMAR
Right of Way Agent

cc. Christine Fanous, SCE
Ben Harvey, SCE

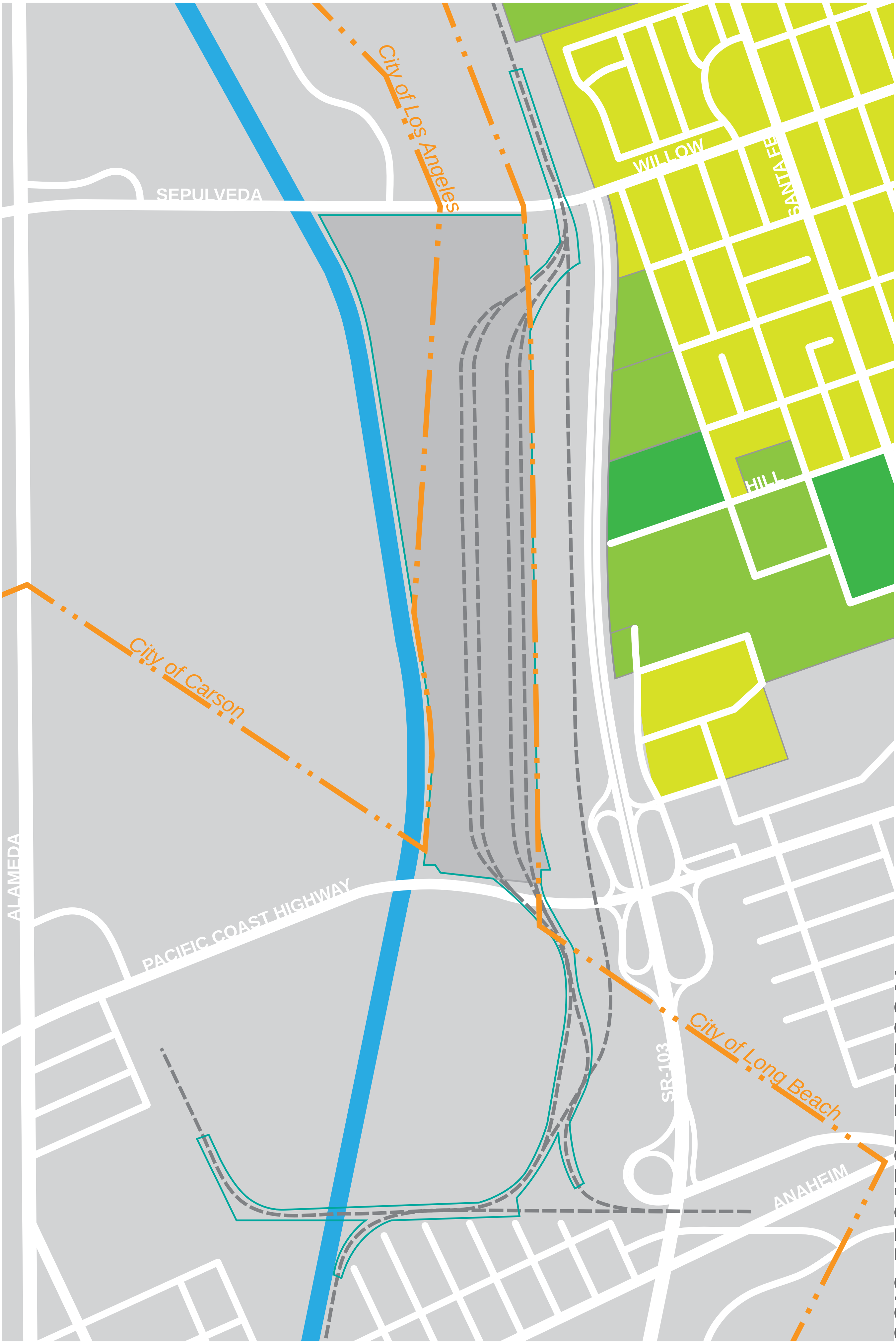
1150 Walnut Grove Ave.
Rosemead, CA 91770

Exhibit A

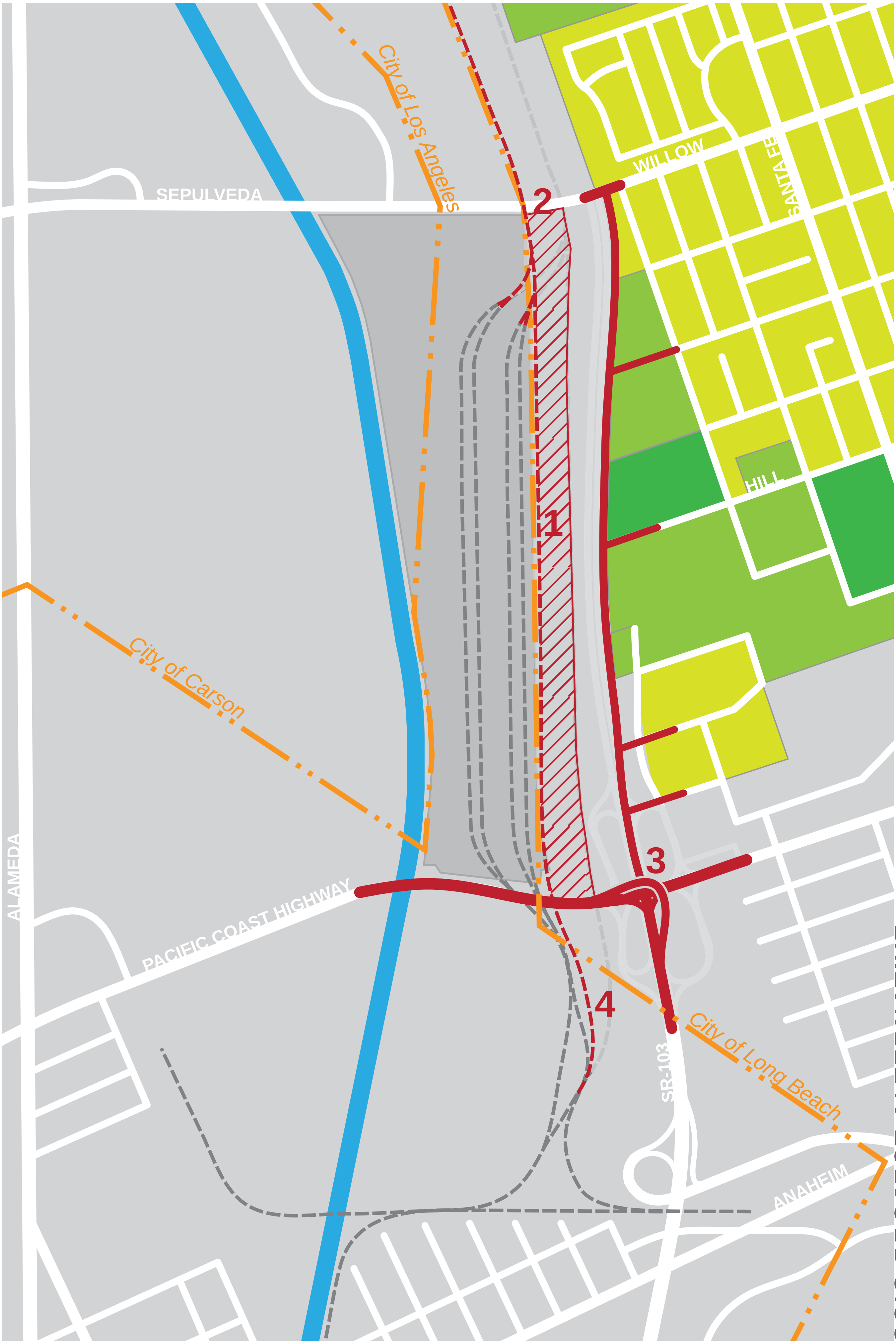
Attachments from Comment Letter 92



SCIG-DEIR PROJECT MAP



SCIG PROJECT PROPOSAL



SCIG PROJECT ALTERNATIVE

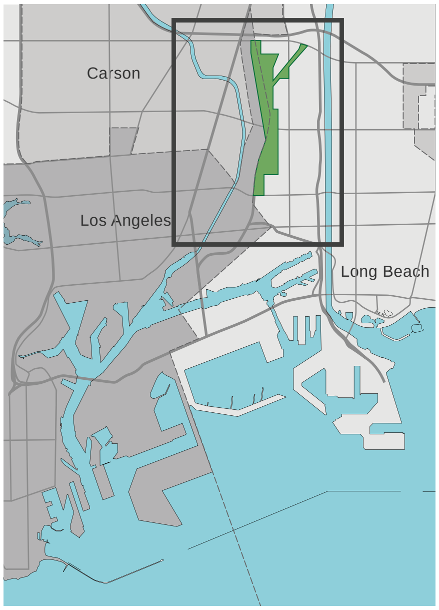
THE YARDS: open space proposal

REGIONAL PARK Create a regional-scale park to serve the Westside and other surrounding communities.

ENVIRONMENTAL BALANCE Provide a carbon sink to mitigate port related air pollution while reducing urban heat island effect.

LAND-USE SEPARATION Establish a greenbelt that physically separates the residential population from freight infrastructure.

IMPROVE LOCAL CONNECTIVITY Improve local infrastructure serving goods movement and residential community.



Vicinity Map

Cornfields State Park in Los Angeles (former railyard)

Why Here?

LAND OF OPPORTUNITY
Long Beach is one of the densest cities in the nation with few opportunities to create new parks for communities most lacking. Because of land-use patterns, West Long Beach has perhaps the best prospects for developing a new park of substantial size.

LIMITED PARK SPACE
West Long Beach is woefully underserved by open space. There is less than one acre of public parks per 1,000 residents where the Eastside of Long Beach has over 16 acres per 1,000 residents including four of the city's largest parks.

ENVIRONMENTAL JUSTICE
West Long Beach is completely surrounded by the port, refineries, industry and freeway infrastructure impacting resident's quality of life. In most cases there is little physical separation from the predominantly low-income, minority neighborhood.

Why Now?

NEW CONSTRUCTION
Hundreds of acres of land and dozens of miles of train tracks will be redeveloped as part of three new and modernized rail facilities. Instead of moving existing facilities there is a unique opportunity to plan them holistically to benefit everyone.

INFRASTRUCTURE REALIGNMENT
New infrastructure projects around West Long Beach will result in more efficiency and greater capacity for goods movement from the port. Many of these projects would actually create the opportunity to repurpose redundant infrastructure for public use.

ENVIRONMENTAL MITIGATION
There are currently seven major infrastructure projects proposed in and around West Long Beach. While environmental mitigations are proposed for these projects they could achieve more as part of a larger vision for benefiting the community.

Questions?

Contact Brian Ulaszewski bulaszewski@hotmail.com 323.309.7932

THE YARDS open space proposal

CONSOLIDATE PORT-SERVING INFRASTRUCTURE

Shift port support facilities and infrastructure (existing and/or proposed) to the west, adjacent to the Dominguez Channel and the Alameda Corridor. Realign San Pedro Railroad Branch west to more efficiently serve port support facilities.

RECONFIGURE CITY-OWNED TERMINAL ISLAND FREEWAY WITH SAN GABRIEL AVENUE

The City of Long Beach owned portion of the Terminal Island Freeway north of Pacific Coast Highway carries fewer vehicles than Fourth Street (one travel lane in either direction, with a left turn lanes). Replacing the last one-mile length of the freeway with a neighborhood scale street can improve local circulation while shifting truck traffic to the Alameda Corridor.

REPURPOSE SOUTHERN CALIFORNIA EDISON RIGHT-OF-WAY

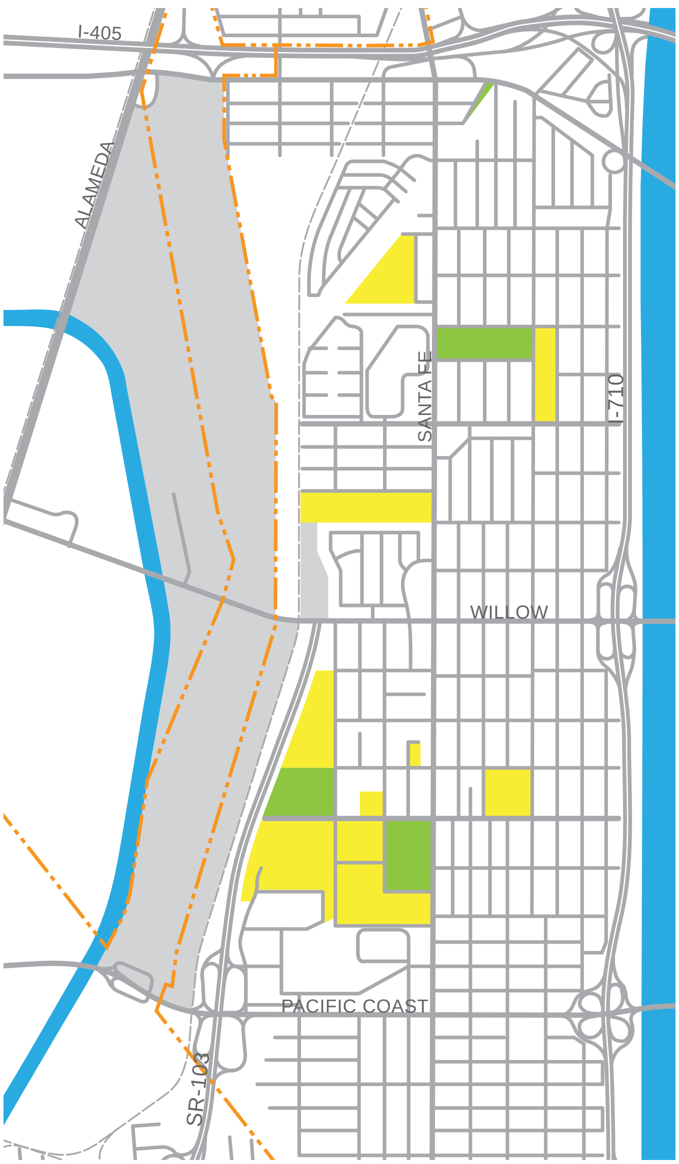
A large portion of the Southern California Edison (SCE) transmission corridor on the Westside is currently vacant of accessory uses. While retaining necessary access and security for electrical transmission facilities, enter into lease our purchase agreement for public use of the ground plain.

SHARE LONG BEACH UNIFIED SCHOOL DISTRICT RECREATION FACILITIES

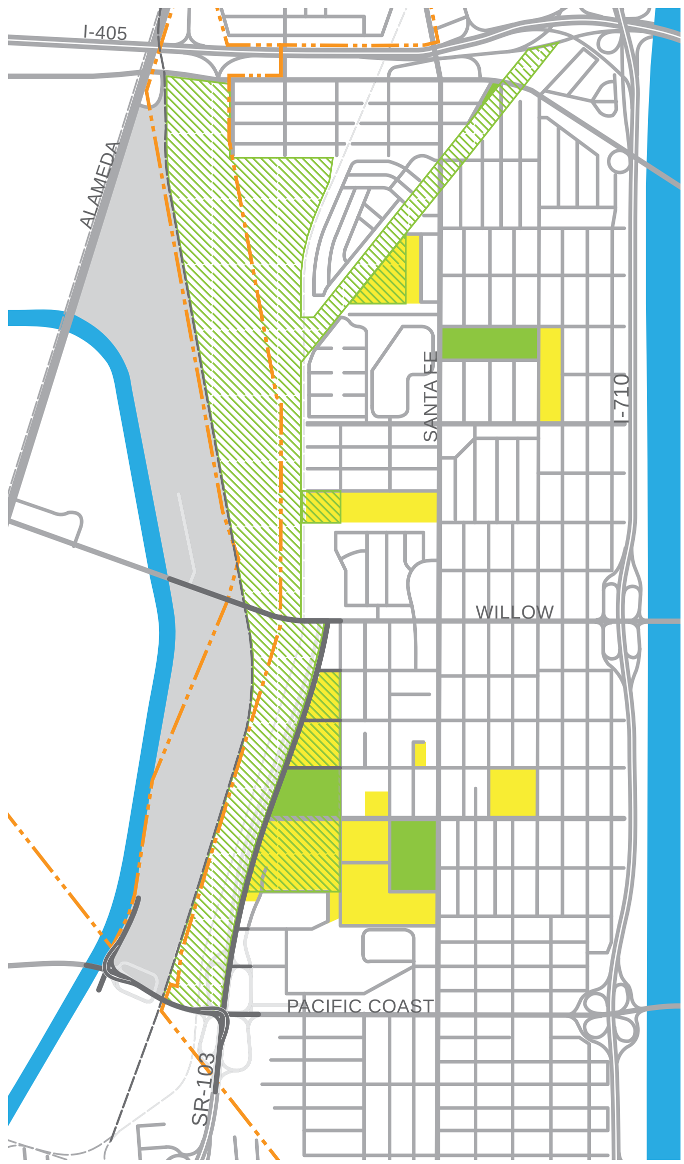
Four Long Beach Unified School District (LBUSD) campuses abut the western edge of city boundaries and port supporting infrastructure. Establish reciprocal joint-use agreements for the recreational facilities adjacent to the SCE transmission corridor.

DEVELOP REGIONAL SCALE PARK IN WEST LONG BEACH

Combine vacant parcels, under-utilized right-of-ways to create the second largest park in Long Beach along the western edge of the City.



Focus Area - Before



Focus Area - After

Attachments from Comment Letter 104

CALIFORNIA
CEA ENVIRONMENTAL
ASSOCIATES

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Kirk is the Founder of CEA and has been at the helm as a Principal since 1984. His deep experience in energy and environmental regulation provides the foundation for CEA's work with a variety of private and public sector clients. Prior to establishing CEA in 1984, Kirk was the Under Secretary of California's Natural Resources Agency and served as the Director of the Office of Appropriate Technology. He also held various positions at the U.S. Department of the Interior. At California's Natural Resources Agency, Kirk was responsible for managing budget and policy initiatives of the agency's nine departments. He resolved policy conflicts among departments, cabinet officers, legislators, companies, and private citizens. Later, he worked as a consultant with the Environmental Defense Fund to help implement programs in energy, water, and hazardous materials.

Kirk has led large-scale regulatory reform and strategic planning projects for major manufacturing and transportation companies as well as for trade associations and nonprofits. He has represented individual clients and trade associations before legislative and regulatory agencies in California and Washington, D.C. In July 1999, Governor Davis appointed Kirk as a public member of the California Board of Forestry, where he served as the Vice-Chair of the Board until 2007. Kirk currently serves as the Chairman of the Board of the Institute for Local Self-Reliance and on the Boards of the Pacific Forest Trust, the Blue Mountain Center and the Point Reyes National Seashore Association.

Kirk has a master's degree in Natural Resources Policy and Management from the University of Michigan and a bachelor's degree from Trinity College.

Attachment 2

Roadmap for Moving Forward with Zero Emission Technologies at the Ports of Long Beach and Los Angeles

Technical Report

Updated August 2011

FINAL

Attachment 2

Table of Contents

Acronyms and Abbreviations

ACTA	Alameda Corridor Transportation Authority
AQMD	South Coast Air Quality Management District
CAAP	San Pedro Bay Ports' Clean Air Action Plan
CalHEAT	California Hybrid Efficient and Advanced Truck
CARB	California Air Resources Board
CCDoTT	Center for Commercial Deployment of Transportation Technologies
CEC	California Energy Commission
CHE	cargo handling equipment
CO_2	carbon dioxide
DOE	United States Department of Energy
DPM	diesel particulate matter
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EPA	United Stated Environmental Protection Agency
FRA	Federal Railroad Administration
GA	General Atomics
GCWR	gross combined weight rating
GHG	greenhouse gas
HC	harbor craft
HDV	heavy-duty vehicle
hp	horsepower
HSRT	high-speed, high-performance regional transportation system
HTUF	hybrid truck user's forum
ICTF	Intermodal Container Transfer Facility
LSM	linear synchronous motor
maglev	magnetic levitation
MCS	Major Corridor Study
Metro	Metropolitan Transportation Authority
MOU	memorandum of understanding
mph	miles per hour
NOx	nitrogen oxides
OCS	overhead catenary system
OGV	ocean-going vessel
PHL	Pacific Harbor Line
PM	particulate matter
ppm	parts per million
RFCS	Request for Concepts and Solutions
RFP	Request for Proposals
RL	railroad locomotive
RMG	rail-mounted gantry crane
ROW	right of way
RTG	rubber-tired gantry crane

Acronyms and Abbreviations (continued)

RTP	Regional Transportation Plan
SCAG	Southern California Association of Governments
SoCAB	South Coast Air Basin
SOx	sulfur oxides
TAC	technical advisory committee
TAP	San Pedro Bay Ports' Technology Advancement Program
TTC	Transportation Technology Center
UP	Union Pacific Railroad
USC	University of Southern California
ZECMS	Zero Emission Container Movement System

1. Introduction

For the last five years, the ports of Long Beach and Los Angeles have been evaluating zero emission goods movement technologies prompted by Boards of Harbor Commissioners that are keenly interested in leading the nation's two greenest ports into a cleaner future, by community demands for cleaner air, and by regulatory pressure to reduce the ports' "fair share" of air emissions. The purpose of this report is to provide a roadmap for moving forward with the identification, evaluation, and integration of zero emission technologies into ongoing port-related goods movement.

This report was jointly prepared by the staffs of the Port of Long Beach and Port of Los Angeles, with assistance from Starcrest Consulting Group, LLC. This report will:

- Define and clarify what is meant by "zero emission technologies" and how employing such technologies in the appropriate manner can assist the ports and the region in meeting their air quality and health risk reduction needs;
- Describe the technical and programmatic attributes of candidate zero emission technologies, including how they can be potentially integrated into goods movement;
- Explain the criteria and the process used to uniformly and impartially evaluate the technical and programmatic viability of zero emission technologies for drayage over short-haul distances and for in-terminal container handling equipment, and that will also be used for evaluation of additional technologies and other source categories in the future;
- Present the findings of the evaluation process for zero emission technologies, including constraints and opportunities related to near-term and longer-term options;
- Present recommendations for "next steps" in implementing zero emission technologies into port-related goods movement operations.

By the end of this paper, the reader should have a clear understanding of the roadmap for moving forward with zero emission technologies in port-related operations, based on the following key principles:

- The ports should pursue zero emission technologies for those segments of port operations where technically feasible and economically viable solutions are most likely to develop - on-road drayage, in-terminal container handling, and railroad locomotives.
- The ports must identify the technology options that are best suited for integration into port-related operations (e.g., duty cycle).

- The ports must preserve flexibility in their approach to allow future zero emission technology advancements to be integrated into port-related operations.
- The ports must consider the ability of any proposed zero emission strategy to scale out to the region in order to maximize port-related and regional air quality and health risk reductions.
- None of the zero emission technology options considered to date is ready for full-scale implementation. However, the ports will immediately move forward with demonstrations and collaborative efforts that advance promising technologies toward feasible real-world implementation.

Further, the ports must consider that, when evaluating the potential benefits and costs of the various zero emission technology options, resources will also be needed to help develop and implement control strategies for ocean-going vessels (OGVs) and harbor craft in order to achieve the San Pedro Bay Standards.

1.1. What are Zero Emission Technologies?

"Zero emission technologies" have been defined by the California Air Resources Board (CARB) as technologies that do not directly emit criteria pollutants, such as hydrocarbons, carbon monoxide, nitrogen oxides (NOx) or particulate matter (PM). Zero emission technologies may indirectly produce small amounts of emissions, for example, when an electric vehicle plugs into grid power to recharge the on-board batteries, therefore contributing in small part to emissions at the power plant source.

Since 2006, the ports have been evaluating opportunities for Zero Emission Container Movement Systems, or ZECMS, to move cargo through the ports and into the region using technologies that do not burn fossil fuels and therefore do not emit air pollutants "at the tailpipe".

The ZECMS title however gives the impression that there will be a "one-size-fits-all" zero emission option that will apply in all port-related operations. As will be discussed more fully below, such a concept is misleading and limiting, and does not fully address the needs of the various mobile sources involved in port-related operations. Accordingly, for the purposes of this paper and moving forward, with the exception of references to past activities, these technologies will be referred to by the more general and appropriate terminology of "zero emission technologies".

1.2. The Need for Zero Emission Technologies

The economic benefits of port-related activity are felt throughout the nation. However, the fact that the environmental impacts of trade are disproportionally felt in the local region led to the joint ports' landmark environmental initiative, the 2006 Clean Air Action Plan (CAAP). In the 2010 CAAP Update, the ports underscored their commitment to air quality improvement with the adoption of the San Pedro Bay Standards, which are comprised of two components: 1) reduction in health risk from port-related diesel particulate matter (DPM) emissions in residential areas surrounding the ports, and 2) "fair share" reduction of port-related air emissions to assist the region in achieving federal air quality standards. These components reflect the ports' stated goals of reducing health risks to local communities from port-related sources and reducing emissions to support the attainment of health-based ambient air quality standards on a regional level.

Specifically, the ports' Health Risk Reduction Standard is to reduce the population-weighted cancer risk of ports-related DPM emissions by 85% by 2020, relative to 2005 conditions, in highly impacted communities located near port sources and throughout the residential areas in the port region. The Emission Reduction Standards, relative to 2005 conditions are, by 2014, to reduce emissions by 22% for NOx, 93% for sulfur oxides (SOx), and 72% for DPM, and, by 2023, to reduce emissions by 59% for NOx, 93% for SOx and 77% for DPM.

While the ports have already made significant progress toward meeting these goals, as reflected in each port's annual emissions inventories, emissions forecasting indicate that the currently known emission reduction strategies will not be adequate to achieve the aggressive goals of the San Pedro Bay Standards. As a result, the ports must stay focused on identifying and reducing sources of port-related emissions. Staff believes that implementation of zero emission technology options could provide significant benefits to the ports, bringing them closer to achieving these goals, and in turn, assist the region in meeting national attainment standards.

Further, the South Coast Air Quality Management District (AQMD) has stated that in order to achieve the proposed federal ozone standards, the majority of land-based mobile sources will need to utilize zero emission technologies. The proposed U.S. Environmental Protection Agency (EPA) revised standards would reduce the 8-hour primary standard for ozone to a level between 0.070 and 0.060 parts per million (ppm), down from the 2008 standard of 0.075 ppm. The proposed rule also includes a separate cumulative "secondary" standard to protect the environment, especially plants and trees. If the proposed federal ozone standard is adopted, significant changes will be needed throughout all industries, as well as by private consumers, to meet these stringent air quality requirements for the region.

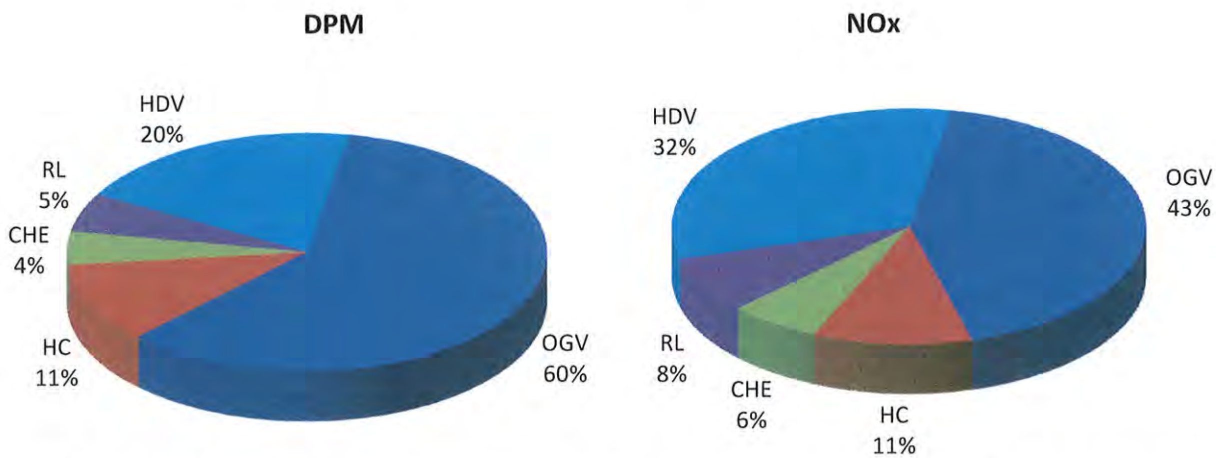
Additionally, utilization of zero emission technologies could be a significant strategy for reducing greenhouse gas (GHG) emissions. Each port, in cooperation with their respective City, has initiated a process to quantify, evaluate and implement strategies to reduce GHG emissions from their administrative operations as well as from port-related activities of their tenants and customers.

Finally, energy security (i.e., reducing dependence on foreign oil) is also a significant consideration as the ports transition into the future. Uncertainty about potential future supplies of oil and rising costs provide another reason for moving away from technologies that rely on fossil fuels to technologies that are powered by electricity ideally produced using renewable energy sources.

1.3. Potential Air Quality Benefits from Implementing Zero Emission Technologies at the Ports

The emissions source categories involved in port-related goods movement operations are OGVs, cargo handling equipment (CHE), drayage trucks (HDVs), rail locomotives (RL), and harbor craft (HC). Figure 1 is derived from each port's 2009 emission inventories and shows the relative contribution of emissions broken down by the source categories associated with such port-related sources.

Figure 1: 2009 DPM and NOx Emissions by Port Source Contribution



While the CAAP includes measures to mitigate air pollutant emissions from each of these major source categories, not all source categories are good candidates for transition to zero emission operation. For example, outside of at-berth operations (i.e., shorepower), it is not practical at this time to pursue zero emission operation of OGVs that call at the ports or harbor craft that operate within port waters due to technical and operational constraints.

The emissions standards being promulgated for OGVs and harbor craft by the regulatory agencies (International Maritime Organization, EPA, and CARB) do not require, nor even approach, zero emission levels. Secondly, and most importantly, zero emission technologies for commercial marine vessels do not currently exist and no practical zero emission technology solutions have been identified. While the goal of "zero emissions" is not appropriate for these source categories, technology options are being developed and implemented to mitigate emissions from OGVs and harbor craft, including the six OGV measures and one harbor craft measure included in the 2010 CAAP Update[1]. In fact, Foss Maritime operates the world's first hybrid-electric tugboat, demonstrating the opportunity for technology migration across applications. While not technically a zero emission tugboat, significant reductions in emissions and fuel consumption are being realized as a result of this advanced technology, which relies on earlier technology developments in the zero emission vehicle market.

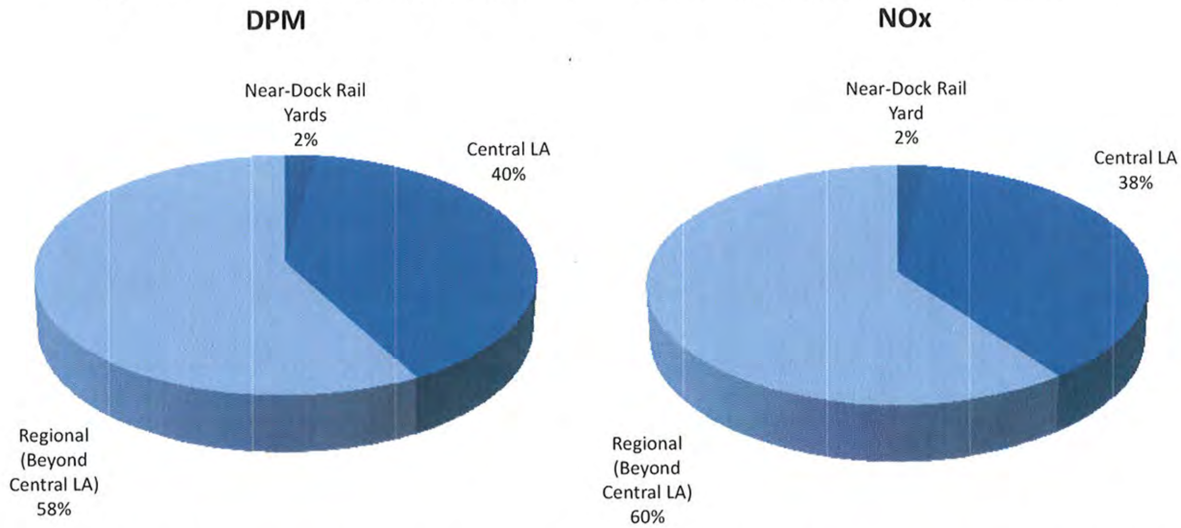
Additional emission reduction technologies for OGVs and harbor craft are being demonstrated under the ports' Technology Advancement Program (TAP). However, even with the successful implementation of these marine vessel emission reduction strategies, OGVs and harbor craft will remain the dominant source of port-generated emissions and the largest source contributor to community health risk for the foreseeable future. These two source categories represent 71% of total port DPM emissions and 54% of total port NOx emissions as documented in the 2009 emissions inventories. Therefore, while the ports must be diligent in their efforts to advance zero emission technologies, they must also be mindful that considerable resources will be needed to significantly reduce emissions from OGVs and harbor craft to achieve the San Pedro Bay Standards.

Technically feasible and economically viable zero emission options are most likely to develop for on-road container drayage conducted between the ports and destinations throughout the region, in-terminal container handling, and rail locomotives used in switching and line-haul operations.

In 2009, on-road drayage trucks produced 20% of total port-related DPM and 32% of total port-related NOx emissions. Of note, these percentages are anticipated to be reduced over the next few years with implementation of the Clean Trucks Programs at the ports. As shown in Figure 2, on-road drayage trucks emit the majority of their emissions during trips throughout the region. In 2009, *on-road truck emissions associated with the transport of cargo between port terminals and the Intermodal Container Transfer Facility (ICTF) represented 2% of total truck DPM emissions and 0.4% of total port DPM emissions.* On-road truck emissions associated with regional drayage represented 98% of total truck DPM emissions and 19% of total port DPM emissions in 2009. Therefore, while near-term efforts should move forward to develop technologies that can reduce emissions from on- and near-port drayage truck operations, ultimately, to provide the greatest benefits, zero emission technologies must be implemented on the regional scale.

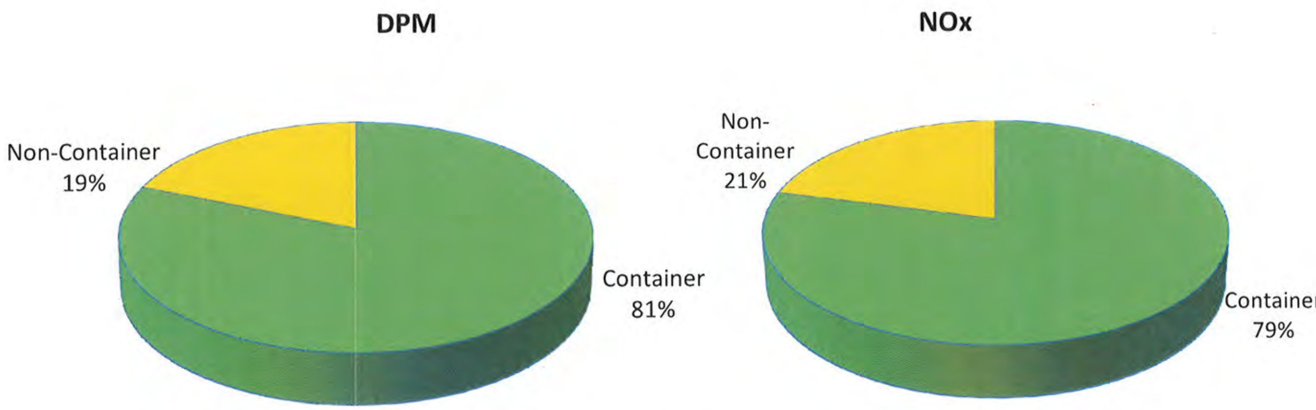
[1] 2010 CAAP Update includes the following OGV Measures: Vessel speed reduction (OGV1); At-berth emissions reductions (OGV 2); Low-sulfur fuels in OGV auxiliary engines and boilers (OGV 3) and in main engines (OGV4); Cleaner OGV Engines (OGV 5); and OGV Engine Emissions Reduction Technology Improvements (OGV 6). Harbor craft CAAP measure is HC1 – Performance Standards for Harbor Craft.

Figure 2: 2009 On-Road Drayage Truck DPM and NOx Emissions Contribution, by Mode



Cargo handling operations at marine terminals and intermodal facilities in close proximity to the ports generate 4% of total port-related DPM and 6% of total port-related NOx emissions. Figure 3 provides the breakdown of DPM and NOx emissions from CHE operations during 2009 at container versus non-container terminals. Since the majority of emissions from CHE are produced at container terminals, greater emissions benefits can be achieved by prioritizing implementation of zero emission technologies for CHE operations at container terminals.

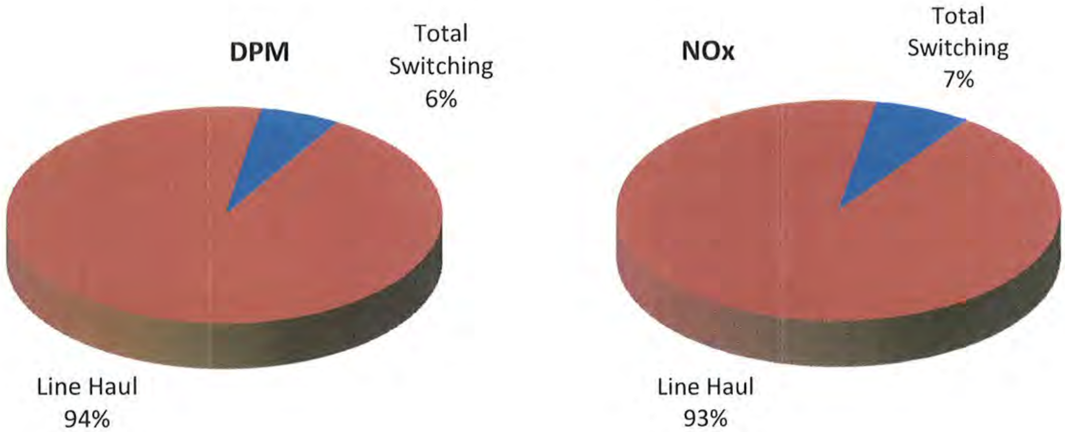
Figure 3: 2009 DPM and NOx Emissions Contribution from CHE by Terminal Type



Port-related rail operations generate 5% of total port DPM and 8% of total port NOx emissions. Rail locomotive emissions are primarily from line haul operations. As shown in Figure 4, 94% of DPM emissions and 93% of NOx emissions associated with port-related rail operations in 2009 were generated by the line-haul locomotives. Rail locomotive emissions are a regional source of air pollution;

thus, to maximize the emissions benefits, zero emission options targeting locomotive emissions should be pursued on a regional scale.

Figure 4: 2009 DPM and NOx Emissions Contribution by Rail Mode



The above analysis of port source emissions is the basis for seeking zero emission options for both port-scale and regional-scale goods movement. On the port scale, zero emission options will target emissions generated by short-haul container drayage and marine terminal operations. On the regional scale, zero emission options will target emission reductions from medium-haul drayage and rail.

Thus, for a zero emission technology to be an effective strategy in achieving the San Pedro Bay Standards, it must have scalability and connectivity throughout the region, and not applied only at discrete marine terminals or intermodal facilities within port boundaries. A zero emission option that connects only point "A" to point "B" within the ports, without the flexibility for expansion is not a viable zero emission solution for meeting the ports' goals.

1.4. The Ports' Role in Advancing Zero Emission Technologies

While the ports are principally interested in zero emission options to help them meet their health risk and "fair share" emission reduction commitments, the ports are also in a unique position to make additional, substantive contributions on a regional, national, and potentially global scale through developing, demonstrating, and supporting deployment of zero emission technologies.

Through the advancement of zero emission technology options, the ports are positioned to assume a lead role in the demonstration of zero emission transportation technologies and serve as a "regional test bed". Because port-related operations typically involve rigorous duty cycles, zero emission technologies that demonstrate the requisite levels of durability and reliability at the ports of Long Beach and Los Angeles can be replicated not only at other ports, but also in other non-marine applications.

Additionally, the pursuit of zero emission technologies provides an opportunity to serve as a "regional catalyst", stimulating both the pace of technology development as well as promoting economic development in Southern California. Currently, at least two zero emission vehicle manufacturers have established their businesses within the greater Los Angeles area, with the expressed intent of manufacturing zero emission on-road drayage trucks and off-road yard tractors for the port-related industry at commercial production rates. To ensure these technologies are carried beyond the ports, these efforts must be conducted with the support and collaboration of the regional planning agencies, including Metropolitan Transportation Authority (Metro), Southern California Association of Governments (SCAG), Gateway Cities Council of Governments, and AQMD.

2. Progress Toward Zero Emissions – Accomplishments to Date

Since 2006, the ports have advanced zero emission technologies through multiple pathways, investing over $4 million to date in this effort. The TAP has focused on numerous technologies, including zero emission options, which are ready for prototype demonstration in port-related applications. In addition, staff have also explored longer-term and larger-scale zero emission options through the ZECMS process.

2.1. Technology Demonstrations through the Ports' TAP

The mission statement for the ports' TAP is *"...to accelerate the verification or commercial availability of new, clean technologies, through evaluation and demonstration, to move towards an emissions-free port"*. The TAP is currently evaluating and demonstrating technologies that could eventually lead to deployment of zero emission technologies for sources in port-related operations. Some of those technologies represent interim or transitional technologies that help to significantly reduce air emissions, but are not yet emission free. Nonetheless, the deployment of these technologies in the near term will help the ports reduce air emissions and associated health risks while continuing to strive for full deployment of zero emission technologies in the appropriate areas of port-related goods movement for the future.

In 2007, the Port of Los Angeles and AQMD initiated a demonstration of the Balqon lead-acid battery electric truck. After initial testing, design upgrades were proposed for the battery management system, including an upgrade to a lithium-ion battery. In 2008, the Port of Los Angeles approved moving forward with phase 2, to purchase and test the upgraded systems for terminal applications, and phase 3, to purchase and test units made specifically for drayage. Phase 2 testing is currently underway. In addition, in an effort to further increase the range of the Balqon trucks, Port of Los Angeles is moving forward with combining the lithium-ion battery truck with Vision Motor Corporation's hydrogen fuel cell. Phase 3 of the system is anticipated to proceed in 3rd Quarter 2011. The tests for phases 2 and 3 will use upgraded lithium ion battery packs, which increase the energy capacity of the units.

The joint ports' TAP demonstrations for the Vision Motor Corporation's hydrogen fuel cell/plug-in electric on-road truck and terminal tractor began in late-2010, with testing of the two prototype vehicles anticipated to begin in 3rd Quarter 2011. The performance of these vehicles will be tested in various terminal and short-haul operations to evaluate their hauling capacity, range, speed, and reliability in the various duty cycles over an 18-month period.

The ports are also actively working with other technology developers as they prepare proposals for consideration through the TAP and anticipate additional zero emission technology demonstration projects to be brought forward for Board consideration later this year.

While these technology projects are underway, until they have successfully completed their prototype testing and are being produced for the commercial market, they are not yet considered viable options[2].

Further, through the TAP, the ports participated in regional and national efforts to develop advanced, lower emissions truck technologies including the national Hybrid Truck Users Forum (HTUF) and the California Hybrid Efficient and Advanced Truck (CalHEAT) research groups. Finally, the ports developed a port drayage truck duty cycle to provide technology developers with a detailed technical understanding of the performance requirements for a typical drayage truck.

2.2. The Ports' ZECMS Process

The concept of Zero Emission Container Movement Systems (ZECMS) has been under investigation for many years. The ports have been actively engaged or the lead agency in these evaluations.

In 2006, the ports evaluated various zero emission technologies through a Request for Proposals (RFP) process. The resulting evaluation report, issued in early 2008 by Cambridge Systematics, identified that

[2] TIAX LLC, *Technology Status Report – Zero Emission Drayage Trucks*, Prepared for the Port of Long Beach and Port of Los Angeles, June 2011.

none of the 13 technologies evaluated was deemed ready for deployment at that time. The process, however, provided valuable insight into the range of ZECMS approaches that could be pursued. As a follow-up to the RFP, and in response to unsolicited proposals by technology vendors, the Port of Long Beach (POLB) performed a right-of-way study to evaluate various routes for a potential fixed guideway system, identifying two potentially feasible routes between the ICTF and POLB's Pier A terminal. In mid-2009, the ports issued a Request for Concepts and Solutions (RFCS) which encouraged submissions of proposals to design, build, and operate a ZECMS between Pier A and the ICTF. The ports, aided by an independent team of technical experts from the Keston Institute for Public Finance and Infrastructure Policy at the University of Southern California (USC), reviewed seven proposals ranging from magnetic levitation (maglev), to linear-synchronous motor (LSM), to vacuum-propulsion technologies.

The USC Keston Institute presented their findings in mid-2010, concluding that none of the proposals were sufficiently mature to commit to a full-scale operational deployment or demonstrated they could deliver a reliable and financially sustainable system at this time. While the general level of proposed systems may have demonstrated experimental proof of concept in a laboratory environment, they all had shortcomings including immature technology, technology that was not proven or tested in port duty cycle applications, and/or technology that lacked a viable financial plan. Debrief interviews with several of the RFCS respondents indicated that additional research and development were needed on their proposed technology, as well as coordinated planning efforts with other regional stakeholders, including regulatory and transportation agencies.

2.3. Regional Zero Emissions Efforts

2.3.1 Metro's Freeway Major Corridor Study

In March 2005, following an extensive technical review and community outreach process, Metro completed the I-710 Freeway Major Corridor Study (MCS). The study analyzed existing and predicted congestion and mobility along the I-710 corridor in order to develop transportation solutions to preserve and enhance the quality of life of surrounding neighborhoods and communities. The study took into account projected increases in container volume at the ports of Long Beach and Los Angeles, the corresponding increase in container truck traffic volume along the I-710, as well as the physical condition of the I-710 freeway infrastructure. Priorities identified by stakeholders during the MCS process included:

- Improve air quality in communities adjacent to the I-710;
- Improve mobility, congestion and safety along the freeway corridor; and
- Assess alternative, "green" goods movement technologies.

The I-710 EIR/EIS studied 18 miles of the I-710 freeway between the Ports and the Pomona Freeway (SR-60). Four alternatives were analyzed in the EIR/EIS:

- No Build Alternative - As required by federal law, the "No Build Alternative" includes transportation improvement projects already programmed or committed to be constructed by the EIR/EIS planning horizon year of 2035;
- Ten Lane Facility - Widen the I-710 freeway to ten lanes for the length of the corridor;
- Ten Lanes and Four Separate Freight Lanes - Widen the freeway to ten general purpose lanes throughout the length of the corridor and add four separated freight movement lanes for exclusive use by conventional trucks;
- Freight Lanes Dedicated to Zero Emission Trucks - Includes all the improvements in the previous alternative, but requires use of zero emission technology to move goods in the freight lanes.

The results of the I-710 Corridor Project EIR/EIS were published in January 2009 in Metro's *Alternative Goods Movement Technology Analysis –Initial Feasibility Study Report*[3].

Two categories of zero emission technologies were assessed for potential I-710 application: automated fixed-guideway systems and battery electric trucks. The report characterized each category of alternative technology in terms of guideway requirements, propulsion, energy consumption, command and control, terminal interfaces, switching, sorting and storage, system operations, and system assurance.

In light of the apparent property requirements for deployment of an automated fixed-guideway technology at the ports and intermodal rail facilities, a new type of battery electric truck technology was considered that would interface with ports and rail terminals as conventional trucks do today, but would operate on a dedicated guideway subject to controls that safely optimize capacity. The report concluded that such a technology does not exist as a commercial product today, but would incorporate characteristics of existing freight and passenger technologies. It was also conceived that drayage trucks powered by electric motors could draw wayside electric power along the corridor and operate on battery power at the ports and intermodal rail facilities.

2.3.2 SCAG's Goods Movement Plan

The SCAG's Regional Transportation Plan (RTP) represents the "long-term investment framework for addressing the region's transportation and related challenges"[4]. An important effort under the 2008

[3] Final Report: Alternative Goods Movement Technology Analysis –Initial Feasibility Study Report, WBS ID:160.10.60, Los Angeles County Metropolitan Transportation Authority, January 6, 2009.

[4] 2008 Regional Transportation Plan, *http://www.scag.ca.gov/rtp2008/pdfs/finalrtp/f2008RTP_ExecSum.pdf*

RTP is development of SCAG's Comprehensive Regional Goods Movement Plan and Implementation Strategy which seeks to optimize the region's transportation system with the application of new technologies. This plan will include evaluation of all freight modes relative to economic efficiency, congestion mitigation, air quality improvements, and system security enhancements. The regional goods movement system defined through this plan will "feed" the upcoming 2012 RTP, which is also under development.

Specifically, SCAG's vision includes the introduction of a high-speed, high-performance regional transport system (HSRT). An HSRT system could potentially include new alternative, zero emission, technology-based systems that can provide enhanced throughput and reliability from the ports of Long Beach and Los Angeles to an inland port facility. The system would capitalize on the synergy of multiple uses on a single infrastructure by operating on shared alignments with a HSRT passenger system. Significant additional evaluation is required, especially with regard to the location of an inland port facility and the associated costs. In the 2008 RTP, SCAG estimated the cost to connect the ports to the HSRT to be $18 billion, with an implementation target of 2020.

3. Recommended Direction – A Roadmap to Zero Emissions

3.1. Candidate Source Categories

As described in Section 1, the ports identified the source categories where zero emission technologies best apply – specifically, container drayage conducted between the ports and destinations throughout the region, container handling at marine terminals, and locomotives used in switching and line-haul operations.

For the purpose of this discussion, container drayage is grouped into two modes:

- Short-Haul Drayage - This operation involves very short container moves from two to six miles in length. Cargo moves between the port terminals and the ICTF, which functions as the Union Pacific (UP) near-dock rail terminal, or nearby container yards are included within this category;
- Medium-Haul Drayage
  - Local Drayage - A high concentration of warehouses and truck terminals, as well as a major rail yard (Hobart), exist within 20 miles of the ports. These terminals include distribution centers in downtown Los Angeles, Compton, and Rancho Dominguez. For the purposes of this report, local operation is defined as cargo moves originating or terminating at the ports and having the other end point between six and twenty miles distance from the ports. According to drayage truck origin and destination surveys, approximately 50 - 60% of port drayage truck activity is captured in this range;

- Regional Drayage - At distances greater than twenty miles from the ports but within the South Coast Air Basin (SoCAB), large warehouse facilities are common and may be used to transfer goods for interstate delivery.

Container handling within a marine terminal involves a wide range of specialized CHE, each type of equipment performing a specific function. This equipment includes vehicles such as yard tractors, top handlers, side picks, and rubber tired gantry cranes. A review of the combined ports' emissions inventories indicates that 50% of CHE operating at the San Pedro Bay Ports consists of yard tractors that move containers within the marine terminals and intermodal facilities.

Locomotive activities include switching activities to build trains, occurring primarily within the port boundaries and intermodal yards, and line-haul activities, transporting trains along the rail corridors, typically to destinations outside of the SoCAB.

These four container movement modes – short-haul drayage, medium-haul drayage, cargo handling equipment, and rail locomotives – represent the four highest priority pathways on the road to zero emissions. The sections that follow will discuss the identification and evaluation of candidate zero emission technology options relative to these four priority container movement modes, culminating in recommended next steps in the zero emission roadmap.

3.2. Process to Identify Zero Emission Technology Options

As described in Section 2, the ports employed a structured process to develop the recommended roadmap to zero emissions, first identifying and screening, then evaluating the applicability, compatibility, feasibility, and economic viability of zero emission options at each step in a container's movement through the ports and into the region. Consistent with the principles identified in Section 1, this process included the following key components:

- Development of Operational and Performance Requirements – Characterization of the operations and performance of each segment of container movement, both in-port and on a regional level. This assessment included conducting detailed analytical studies of container drayage and yard tractor duty cycles to define performance requirements.
- Identification of Zero Emission Technologies - A compilation of technical and programmatic information relative to candidate zero emission technologies, including near term technologies undergoing development and demonstration through the TAP, as well as longer-term technologies identified during the ports' ZECMS RFCS process. In addition to technical and programmatic information provided by technology providers, the ports conducted independent

research and evaluation[5] of zero emission options to better understand their level of technical maturity, feasibility, and potential for near term commercialization.

- Evaluation of Candidate Zero Emission Technologies - For the candidate zero emission technologies identified as potentially applicable and compatible within a segment of port-related container movement, a detailed evaluation was performed using the evaluation criteria presented in Section 3.3 below.
- Recommendations – Recommendations relative to specific zero emission technologies that should be advanced by the ports at this time, including next steps.

Through this process, it became clear that due to differences in operational requirements and implementation issues encountered in various segments of goods movement, *there is no single zero emission technology solution that currently exists or is anticipated to become available that satisfies all of the stated principles and evaluation criteria.* A zero emission option for marine terminals will be different from a zero emission technology applied to container movement on a regional scale. This is because the operational requirements of container movement within a marine terminal environment are very different than those associated in moving containers along rail corridors to the edge of the SoCAB boundary or along public roadways from the terminal to the ICTF, downtown Los Angeles, or the Inland Empire. Unfortunately, there are no zero emission technology "silver bullets" that will provide a single solution that serves all stakeholder interests or requirements.

That being said, the port staff identified opportunities in which a zero emission technology that is not included in the near term zero emission roadmap could have a potential role in the longer term. Zero emission technologies being advanced in the near-term will preserve flexibility for future innovations. There are also paths along the roadmap that identify the incremental expansion of zero emission technologies across multiple goods movement segments and multiple source categories. Thus, while no single solution exists for a near term solution, technologies that are not fully developed today may have a more defined role in the future.

It is important to recognize that the identification and evaluation of zero emission options is a dynamic and ongoing process. The roadmap does not identify a specific end point or future state of technology – it is intended to identify steps in the ports' transition to zero emissions that can be supported today with the understanding that advancements in technology readiness and availability will continue to evolve and must be continually assessed. Thus, it is essential that the ports establish and work within a process framework that allows for technology assessment and reassessment, and fosters collaboration with port tenant, customer, regional, and regulatory stakeholders. The ports' TAP is the key element in this ongoing, dynamic process. Through the TAP, the ports will accelerate the verification or commercial

[5] Technology Status Report - Zero Emission Drayage Trucks, Draft Report, TIAX LLC, May 2011.

availability of zero emission technologies across all applicable source categories, through identification, evaluation, and demonstrations. *However, the principal objective of the zero emission roadmap is to identify next steps and get started now.*

3.3. Criteria for Evaluating and Prioritizing Zero Emission Options

In order to evaluate and prioritize candidate technologies and options for inclusion in the ports' roadmap for zero emissions, the ports defined seven decision criteria. These criteria were used to assess competing technologies for short-haul drayage and in-terminal container handling equipment. The evaluation criteria were developed under the guidance of the ports' principles and also derived from criteria used for the TAP to be consistent with the San Pedro Bay Standards. The criteria also favor options that could bring more immediate benefits and that faced fewer technical, operational, economic and implementation obstacles. Finally, the criteria will be used to uniformly evaluate additional technologies and other source categories in the future.

In developing recommendations, the port staff employed the following criteria:

- **Emissions Reduction and Health Risk Benefits** – the zero emission option's anticipated port-related emission and health risk reductions and contribution toward achieving the San Pedro Bay Standards. The magnitude of benefits derived from the zero emission solution should be commensurate with the investment required, i.e., evaluated on a "cost/benefit" basis with preference given to technologies with higher ratios of benefits to cost;
- **Constructability** – including infrastructure and utility requirements, availability of required space, and Right of Way (ROW) acquisition requirements with preference given to projects that can be integrated into the existing infrastructure or those with fewer barriers to construction;
- **Technology Readiness** – the level of technical maturity and feasibility, demonstrated reliability/durability, and commercial availability with preference given to more mature technologies so as to speed the pace of implementation;
- **Operations Compatibility** – the capability of candidate zero emission technologies to be integrated into ongoing port operations and duty cycles, as well as compatibility with existing operations with preference given to technologies that can more easily be integrated into existing operations;
- **Regional Scalability** – the ability of a port-scale zero emission solution to be incrementally expanded to a regional scale (i.e., in-port, port to ICTF, and expansion along corridors like I-710 between ports and downtown Los Angeles and beyond to the Inland Empire) favoring technologies that can be readily expanded to the regional scale;

- **Cost and Economic Sustainability** – the capital, operational, and life cycle cost, need for incentives or subsidies, and the potential to become economically competitive and sustainable relative to conventional container movement operations with preference given to cost-competitive projects;
- **Timeline** – the expected timeframe for zero emission technology demonstration, commercialization, regional expansion, etc. While the timeline is not used as a criterion to approve or reject technologies, it is used to prioritize actions. For the purpose of the zero emission roadmap, discrete timeframes were defined as follows:
  - Near Term timeframe: Within 3 years
  - Longer Term timeframe: Beyond 3 years

3.4. Zero Emission Options for Short-Haul Container Drayage

Two distinct options emerged from the ports' efforts to identify candidate zero emission options to replace or augment short-haul container drayage currently performed by trucks:

1. Deployment of on-road zero emission trucks, including but not limited to battery-electric trucks, zero emission hybrid-electric trucks, electric trucks powered by an overhead catenary system, or electric trucks using wayside power or LSM embedded in existing roadways or dedicated truck lanes;
2. Construction of an automated fixed guideway system incorporating technologies such as maglev or the adaptation of LSM to existing railroad tracks.

These options are described below, specifically the performance requirements and technology status for each, in addition to a recommended approach for moving forward.

3.4.1. Performance Requirements for Short-Haul Drayage Trucks

To successfully develop advanced zero emission trucks for short-haul drayage, vehicle manufacturers must understand the duty cycle requirements of port drayage trucks. To characterize port drayage duty cycle requirements in analytical terms, the ports developed and published detailed duty cycles for drayage trucks serving both the Port of Long Beach and Port of Los Angeles[6] using data obtained from instrumented trucks in actual container drayage service.

[6] Characterization of Drayage Truck Duty Cycles at the Port of Long Beach and Port of Los Angeles; Final Report, TIAX LLC, February 2011.

A typical short-haul drayage duty cycle includes three distinct driving modes:

Creep → Low Speed Transient → Short High Speed Transient

In analytical terms, the requirements of a typical short-haul container dray can be represented as follows:

- Average Duration of Short-Haul Container Dray: 39 minutes
- Average Truck Speed: 7.7 mph
- Maximum Truck Speed During Haul: 42.2 mph
- Average Short-Haul Distance from Port: 5 miles
- Number of Stops During Dray: 31 stops (traffic control, etc.)
- Percentage of Time Spent Idling: 44%

The short-haul duty cycle requirements were then used to define the minimum performance requirements for zero emission drayage truck:

- 80,000 lbs. gross combined weight rating (GCWR)
- 50+ mph top speed with full load
- 20% or greater gradeability at vehicle launch
- 6% gradeability[7] at 40+ mph and 80,000 lbs. GCWR
- Operating time between refueling or recharging must allow for one complete shift (approximately 8 hours) or have comparable fill times as diesel trucks.

Note that the gradeability at 40+ mph is based on the characteristics of the three major bridges in the port area (Gerald Desmond Bridge, Vincent Thomas Bridge, and Commodore Schuyler F. Heim Bridge). It is possible to use other routes to avoid the steep grades on the bridge, possibly lowering the specified grade requirements.

3.4.2 Development Status of Zero Emission Short-Haul Trucks

Vehicles employing partially electrified drive trains have seen dramatic growth in the light-duty market over the last ten years with the commercialization of various hybrid-electric passenger cars. The medium- and heavy-duty markets have also shown recent trends toward electrification of drive trains in

[7] Based on Gerald Desmond Bridge approach grade, Gerald Desmond Bridge Replacement Project Traffic Impact Study, October 2009

both on-road and off-road applications. Several manufacturers are pursuing commercialization of heavy-duty electric trucks that have the potential to meet the basic operational requirements for short-haul drayage trucks.

As identified earlier, two electric truck manufacturers, Balqon and Vision Industries, are currently working with the ports to test prototype on-road electric trucks that meet the CARB definition for zero emission. The Balqon and Vision Industries prototype technologies are being used as examples to characterize the current state of development for zero emission trucks that are potentially suitable for short-haul drayage service at port terminals.

- Balqon Corporation Battery-Electric Drayage Truck - In 2007, the Port of Los Angeles and AQMD entered into a contract with Balqon Corporation to develop and demonstrate a battery-electric truck that could operate within and outside terminal facilities in both on-road and off-road applications. The initial prototype truck, the Nautilus E-30, was completed and tested in early 2008, primarily as an off-road yard tractor. Based on an assessment of the prototype truck's performance by port and AQMD staff, it was determined that an upgraded version of the E-30 had the potential to meet the performance requirements for an on-road short-haul drayage truck. In June of 2008, the Port of Los Angeles approved Resolution Number 08-6571[8], thereby entering into a multi-phased test program with Balqon that ultimately includes the purchase and delivery of five E-30 battery electric on-road drayage trucks that could be used for short-haul operations. This multi-phased test program has been underway primarily focusing on enhancements to the batteries and battery management system. Initial tests have been conducted on yard tractors. Because yard tractors and short haul drayage trucks have similar electric drive system components and duty cycles, many of the lessons learned and potential enhancements, including those made to the batteries and BMS, would assist in the development of the on-road units. Balqon is currently in production of the first on-road unit for short-haul operations, which will be delivered in the third quarter of 2011.

- Vision Industries Hybrid-Electric – The Vision Industries Tyrano™ on-road truck is a special type of zero emission hybrid-electric vehicle that uses battery power for propulsion and an on-board hydrogen fuel cell system to recharge the vehicle's batteries. The vehicles being tested under the ports' TAP include a plug-in option for recharging the batteries; however Vision has stated that the fuel cell can be relied upon to recharge the batteries in lieu of plugging into the electrical grid. The vehicle's performance characteristics, including horsepower, torque, gradeability, etc., are substantially similar to the Balqon E 30 described above. Based on Vision's preliminary vehicle specifications, the Tyrano™ hybrid drive system has the potential to provide adequate horsepower and torque to meet the needs of drayage service. Vision engineers report

[8] *http://www.portoflosangeles.org/Board/2008/June/061908_Special_Meeting_Item1_trans.pdf*

that the Tyrano™ will have a rated gradeability of 13% when fully loaded at 80,000 GCWR; this should enable it to meet all grades that will be encountered in short-haul drayage trucking. One potential performance-related issue is that the Tyrano™ day cab tractor weighs approximately 17,500 pounds; this is approximately 2,000 pounds heavier than a comparable diesel tractor. However, Vision engineers point out that the Tyrano™ tractor's weight distribution has been optimized to help prevent overloading of the front axle when heavy loads are moved. In July 2011, Vision delivered the demonstration unit and the 18 month in-use demonstration was initiated.

Battery and zero emission hybrid electric trucks are expected to initially cost more than double that of a conventional diesel Class 8 on-road drayage truck. The majority of the incremental cost is associated with the battery storage system. Most heavy-duty electric truck manufacturers specify advanced lithium chemistry batteries. These batteries offer the benefits of high levels of electrical energy storage capacity, long life, and lower weight as compared to other battery types. However, at today's production rates, lithium chemistry automotive batteries are the single most expensive component of the electric drive system. As additional hybrid electric and battery electric passenger cars enter the marketplace, it is anticipated that increased production rates, production automation, and competitive market forces will result in economies of scale that ultimately lower the cost of electric vehicle batteries. This is already being seen as it pertains to lithium-ion batteries entering the marketplace.

The reliability and durability of heavy-duty electric trucks in a short-haul port duty cycle have yet to be proven. While the prototype electric trucks are anticipated to be capable of meeting the combination of payload and grade performance requirements necessary for local drayage operation, testing of the initial Balqon units have shown inadequate speed at grade while under load and limited range, indicating further design improvements are needed. To assess the technical capability of the Balqon and Vision Tyrano, a test program is being developed for the TAP demonstration that employs the truck over an extended period of time in actual, fully loaded container drayage service on typical routes.

While Balqon and Vision are used as examples in this report because they are currently being evaluated by the ports, they are not the only Class 8 zero emission truck options in development. The AQMD is currently funding the development of Class 8 battery electric trucks, and manufacturers of Class 5 - 7 battery electric trucks have expressed confidence that existing electric drive systems are scalable to meet Class 8 container drayage operational requirements. Thus, it should not be construed that staff is recommending any specific vendor or vehicle – the reference to electric trucks in the zero emission roadmap includes all electric trucks that meet port requirements and is not limited to these two options.

With respect to electric trucks designed to operate using an off-board electric power source, such as electric trucks powered by an overhead catenary system (OCS) or wayside power, these technologies are not being dismissed as options. These off-board power systems may offer the potential to extend the range of the zero emission trucks beyond what can be provided by the on-board battery system, and can be developed based on the successes and/or lessons learned from the current electric or hydrogen-electric hybrid projects. However, it is important to recognize that commercially available linear induction/linear synchronous motor technologies do not currently exist. While OCS has been widely used in on-road transit bus applications, the need for and benefits of OCS as compared to electric trucks using on-board energy storage (i.e., batteries) for *short-haul drayage* have yet to be identified or evaluated for operation at the San Pedro Bay ports. It is recommended that the ports view the zero emission option of electric drayage trucks as inclusive of all electric power technologies, recognizing that the implementation timeline of each technology will vary, and that some currently infeasible technologies may become viable in the longer term or for range extension, as long as there is flexibility in the implementation to allow for future advancements.

3.4.3. Performance Requirements for Fixed Guideway Systems

The construction of a *fixed guideway* to connect marine terminals with near-dock intermodal facilities as an alternative to zero emission trucks was the predominant theme in the responses received under the ports' RFCS. Technologies proposed for operation on a fixed guideway include maglev propulsion systems, linear induction motor technology (without levitation), vacuum propulsion systems, and OCS. While the details of each propulsion technology vary, the common attribute is that containers are conveyed along a dedicated guideway that requires construction of new port infrastructure.

Because a fixed guideway represents new infrastructure and provides dedicated connectivity between the port terminals and near-dock rail facilities, the typical duty-cycle requirements corresponding to short-haul drayage operations do not necessarily apply. Instead, container movement requirements for a fixed guideway can be specified in terms of connectivity and throughput. To replace short-haul drayage service currently performed by drayage trucks, a fixed guideway option will need to have the following attributes:

- Connect the 13 existing marine container terminals spread throughout both ports to multiple near-dock intermodal facilities;
- Not impede existing on-dock rail or other operations at port terminals or operations at near-dock intermodal facilities;
- Be cost competitive in a reasonable timeframe with existing short-haul drayage services;
- Offer container throughput capacity that equals or exceeds marine terminal drayage requirements.

3.4.4. Development Status of Fixed Guideway Systems

During the ports' RFCS process, an evaluation team comprised of staff from each port, the Alameda Corridor Transportation Authority (ACTA), and a panel of experts selected by the Keston Institute of USC concluded:

- None of the systems proposed are sufficiently mature to commit to a full-scale operational deployment at this time;
- Additional testing that simulates the port environment is needed;
- A full understanding of port duty cycles was absent from all responses;
- None of the submissions adequately addressed the risks of insufficient market demand; and
- Technology and financial risk cannot be fully evaluated until the robustness and reliability of the systems have been demonstrated.

It is possible, and even likely, that issues involving insufficient technology maturity can be resolved through additional research and development. However, constraints imposed by ongoing operations at port terminals present integration issues that may render a fixed guideway solution impractical compared to trucks for short-haul.

To effectively replace current container movement operations, a fixed guideway would need to provide connectivity to at least 13 marine terminals and several near dock intermodal facilities which would require a virtual "web" of dedicated guideways. The method to deliver containers to the guideway, load containers onto the guideway at the marine terminals, and unload containers at the near-dock intermodal facility is currently undefined and must be resolved so as to not adversely impact port terminal and rail yard operations. In addition, construction of a fixed guideway, including elevated guideways, would require acquisition of terminal right-of-way and potentially acquisition of private right-or-way which may be impractical and prohibitively expensive.

Further and very importantly, a fixed guideway solution does not provide regional scalability and connectivity. In order to significantly reduce emissions and make progress toward meeting the ports' goals identified in the San Pedro Bay Standards, a zero emission option must have scalability and connectivity throughout the region, and not be applied only to discrete marine terminals or intermodal facilities near the ports. A zero emission option that is only able to capture operations between the marine terminals and intermodal facilities will, at best, only be able to reduce 0.4% of port-related DPM emissions; whereas if the zero emission option is scalable to the region, it could be capable of reducing 19% of port-related DPM emissions.

From an economic feasibility perspective, a fixed guideway option must compete with current drayage services performed using trucks. If the cost to use the fixed guideway option is greater than the drayage truck rates, then it will not be able to compete in the market, and will therefore not be financially viable. Fixed guideway concepts are the most expensive zero emission options, requiring significant capital investment for construction costs, acquisition of right of way, and loss of revenue for physical land area dedicated to the loading stations. Some of the respondents to the RFCS understated these costs. Hence, the RFCS review team concluded that the commercial financing assumed by some of the respondents may not prove to be readily available at terms that would enable a financially sustainable technology deployment. The conclusion of the port evaluation team was that, under best case assumptions regarding growth in container volume and share of container drayage market capture and absent environmental regulation or significant subsidies, a fixed guideway option will have difficulty competing economically with conventional truck drayage.

A variation on the fixed guideway concept is to adapt LSM to be integrated into existing rail tracks connecting marine terminal on-dock rail facilities with near-dock intermodal rail facilities. This concept offers the potential benefits of lower capital development costs and eliminates right-of-way acquisition issues. LSM technology will be further discussed in Section 3.7 – Zero Emission Options for Regional Rail Locomotives.

3.4.5 Evaluation of Zero Emission for Short-Haul Drayage

The two zero emission options for short-haul drayage, electric trucks and fixed guideway system, were evaluated using the evaluation criteria defined in Section 3.3. The result of this evaluation is provided in Table 1 and discussed below.

Table 1: Assessment of Zero Emission Options for Short-Haul Drayage

Evaluation Criterion	Electric Trucks	Fixed Guideway
Emissions and Health Risk Reduction	Excellent	Excellent
Constructability	Excellent	Poor
Technology Readiness	Satisfactory	Poor
Operations Compatibility	Good	Unacceptable
Regional Scalability	Satisfactory	Unacceptable
Cost and Economic Sustainability	Good	Unacceptable
Timeline for Implementation	Satisfactory	Poor

Excellent Good Satisfactory Poor Unacceptable

Each evaluation criterion is discussed below relative to the two general options:

- Emissions and Health Risk Reduction – both an electric truck and fixed guideway system offer zero emission container transport. It should be noted, however, that a fixed guideway system implementation timeline is significantly longer than the deployment of electric trucks; thus, emission and health risk reductions will be realized sooner under the electric truck option, contributing to achievement of the San Pedro Bay Standards;
- Constructability – Battery electric trucks operate on existing roadways and require no additional right of way or significant infrastructure development. Electric trucks using an OCS or wayside power would require construction of additional infrastructure; however, this is a potential longer term option for short-haul drayage if needed to extend the range beyond what can be provided by the on-board battery system. A new fixed guideway requires acquisition of right of way both within and outside of port boundaries as well as construction of the actual guideway which must connect to all 13 container terminals, the near-dock rail yard and possibly other near-port destinations;

- Technology Readiness – battery electric trucks are being demonstrated today with the goal of moving towards commercialization. Fixed guideway technologies, such as maglev and LSM are in the initial research and development stage of technical readiness;
- Operations Compatibility – Electric trucks, especially those powered by an on-board energy source such as batteries, can be seamlessly integrated into ongoing short-haul drayage operations assuming they have adequate range to perform the work and can be recharged in an acceptable amount of time. A fixed guideway solution would require significant changes to container handling practices within a marine terminal environment, including but not limited to container loading and unloading from the fixed guideway;
- Regional Scalability – Electric trucks, when operational, may be deployed throughout the SoCAB, and development of technology to extend the operational range of electric trucks is ongoing. A fixed guideway would be isolated to the specific locations where it is connected, and therefore does not offer the same level of flexibility and regional scalability;
- Cost and Economic Sustainability – Electric trucks currently carry a price premium and successful deployment of large numbers of zero emission trucks will most likely require funding incentives on an interim basis. It is assumed that such incentives will be made available, as they have been in the past for alternative fuel vehicles. Economies of scale, especially in high cost components such as batteries, will reduce the incremental cost of an electric truck as compared to a conventional diesel vehicle. A fixed guideway system requires significant capital development expenditure and must compete with drayage trucks performing short-haul drayage. The results of the ports' RFCS evaluation suggest a fixed guideway system is not economically competitive for short-haul drayage and not financially sustainable barring significant on-going cost subsidies;
- Timeline for Implementation – Electric trucks are undergoing demonstration in port duty cycles now and more zero emission truck concepts are expected to be demonstrated in the near future. A fixed guideway solution will require many additional years of research and development, design, environmental planning, and construction.

3.4.6 Recommendations for Short-Haul Drayage

The first critical piece in the zero emission roadmap is to continue the demonstration and refinement of zero emission, battery electric trucks for short-haul drayage operations by conducting technical evaluations and testing under the TAP. The goal of these efforts is to ensure the technologies can meet the demands of the port duty cycle, provide the technology developers with a test bed to refine their system designs, and ultimately to accelerate commercialization of zero emission trucks for port operations. *Demonstration and commercialization of zero emission trucks is the #1 priority as it relates to implementing zero emission technologies for short-haul drayage.*

Electric trucks offer:

- Seamless integration into ongoing port operations and offer the highest level of operational flexibility;
- Can be incrementally integrated into port drayage operations;
- Offer flexibility for scaling up to meet the regional needs;
- Do not require construction of new infrastructure or acquisition of right-of-way; and
- Appear economically viable with a high likelihood of self-sustainability as anticipated economies of scale and market forces lower vehicle acquisition costs.

In the near term, the demonstrations of zero emission trucks that are currently underway through the TAP are designed to address the need for zero emission, battery electric technologies for short-haul drayage. The Vision Tyrano truck was delivered in July 2011 and the Balqon truck will be delivered by 3rd Quarter 2011. Both trucks will undergo an 18-month demonstration period in accordance with an approved Demonstration and Test Plan. In addition, the ports will continue to evaluate new technology options by proposers through the TAP. Industry representatives will participate in these projects as demonstration partners and in an advisory capacity, along with the TAP Technical Advisory Committee (TAC), which includes the ports, EPA, CARB and AQMD.

In the longer term, the ports could:

- Continue to move forward with TAP demonstrations of advanced zero emission technologies for short-haul drayage, including conducting broader operational and durability testing, as needed;
- Promote improvements in battery technologies through the TAP;
- Identify funding support for additional demonstration tests;
- Work with industry to evaluate operational compatibility of larger-scale zero emission truck deployment;
- Assist with identifying funding support for purchases of zero emission trucks;
- Assess the need for battery charging and hydrogen fueling infrastructure with larger-scale zero emission truck deployment, and assist as needed and appropriate; and
- Evaluate overhead catenary or other wayside power systems for short-haul drayage, considering at a minimum, the benefits that could be offered beyond the capabilities of a zero emission truck with an on-board battery system, the cost, and the operational constraints.

3.5. Zero Emission Options for Medium-Haul Container Drayage

Medium-haul drayage has been defined as having two subcategories: local drayage, within 20 miles of the ports, and regional drayage, to destinations 20 miles beyond the ports but within the SoCAB.

The implementation of zero emission options beyond the ports' boundaries presents an array of challenges far greater than those associated with short-haul container movement. Outside the ports, issues such as right of way, jurisdictional authority, infrastructure requirements, and particularly cost become primary issues that must be resolved before any specific zero emission option can be deemed fully viable. The implementation of zero emission options beyond the ports' boundaries will require the coordinated efforts of multiple regional stakeholders, including but not limited to Metro, SCAG, Gateway Cities, and AQMD. Therefore, staff recommends that collaboration with regional stakeholders be the first step in a zero emission roadmap for medium-haul container drayage.

3.5.1 Performance Requirements for Medium-Haul Drayage

Medium-haul drayage consists primarily of the movement of cargo along local and regional freight corridors. Typically, medium-haul drayage includes container moves originating or terminating at the ports and having the other end point of the move between six (6) and 60 miles in length - this range effectively covers drayage operations between the ports and distribution centers in the Inland Empire.

While short-haul drayage can be typically characterized by a single duty cycle, medium-haul drayage, from an operational and performance requirements standpoint, is comprised of two duty cycles, represented as follows:

Local Dray (6 to 20 miles) - Creep → Low Speed Transient → Long High Speed Transient

Regional Dray (20+ miles) - Creep → Low Speed Transient → High Speed Cruise

The primary difference between the local and regional cycles is the duration of the high speed portion of the duty cycle. However, as shown below, the average length of a regional medium-haul dray is *five times* that of a local haul:

	Local Haul	Regional Haul
• Average Duration of Container Dray:	64 minutes	118 minutes
• Average Truck Speed:	10.2 mph	27.3 mph
• Maximum Truck Speed During Haul:	48.7 mph	57.6 mph
• Average Medium-Haul Distance from Port:	11 miles	54 miles
• Number of Stops During Dray:	46 stops	33 stops
• Percentage of Time Spent Idling:	41%	25%

The duty cycle requirements for medium-haul drayage, especially those conducted along regional corridors, are significantly more demanding on a truck compared to the short-haul duty cycle discussed in the preceding section. Medium-haul increases the range requirements of a zero emission technology by an order of magnitude compared to short-haul, and in the case of electric trucks, pushes the limits on range that can reasonably be expected from today's state-of-the-art battery-electric drive systems.

Also, drayage truck operations on a local or regional scale are conducted with greater periods of sustained, high speed operation. High speeds under heavy loads quickly consume energy stored within a vehicle's battery pack, dramatically reducing the electric truck's overall range.

3.5.2. Technology Development Status for Medium-Haul Drayage

To expand the capabilities of zero emission drayage trucks beyond the short-haul duty cycle, the introduction of additional zero emission technologies that substantially increase the vehicle's range will be required. Candidate zero emission technologies to extend the range of an electric truck include:

- Extended range battery packs through advanced battery technology, additional storage, or maximizing battery efficiency;
- Augmentation of on-board battery storage, such as hydrogen fuel cells; and
- Use of wayside power, including OCS and incorporation of linear inductive motors or LSM embedded in the roadway pavement.

Current battery technologies do not provide adequate range at a reasonable cost. While efforts are being made to improve battery technologies, no cost-effective options are expected to become available for the Class 8 truck application in the near term. Using an on-board fuel cell as a range extender will be tested by the ports Vision Tyrano truck project starting later this year and continuing for an 18-month demonstration period, however reliability in the short-haul application must first be proven before proceeding with a longer range test. OCS has been used for buses that travel along fixed routes. While the technology is potentially applicable to zero emission Class 8 trucks, further testing would be necessary to determine how such a system could be integrated into existing operations given the wide variety of routes and destinations for drayage trucks throughout the region. Further, an electric truck would be needed to connect to the system, and as stated previously, no such truck is commercially available at this time. A demonstration of this technology could be a logical follow-on after the short-haul drayage truck demonstrations have been conducted. Finally, application of wayside power embedded in the roadway to power electric trucks has never been tested for this type of operation. Development of a system would require significant research and development work before it could be implemented on a large scale.

3.5.3 Evaluation of Zero Emission Options for Medium-Haul Drayage

The criteria established by the ports to evaluate candidate technology options could be used to evaluate technologies for medium-haul drayage. As identified above however, medium-haul drayage is not just a port issue and criteria development and technology evaluation must be conducted in collaboration with regional stakeholders such as Metro, SCAG, Gateway Cities, and AQMD. The ports will seek to work with these and other stakeholders to develop collective criteria to evaluate regional zero emission technology options.

3.5.4 Recommendations for Medium-Haul Drayage

Zero emissions options addressing medium-haul drayage must be compatible with other solutions being developed for the region. Therefore, development of strategies will require a broad-based partnership to make zero emission options a reality.

In the near term, the ports should focus their efforts on the following:

- Establish a regional partnership including Metro, SCAG, Gateway Cities, AQMD, and others and work together to define regional zero emission freight transport needs and develop criteria for evaluating options for moving forward with zero emission technology on a regional scale;
- Build on and leverage the technology platform demonstrated for short-haul drayage;
- Work collaboratively with the regional partners to identify and evaluate specific range extension options for zero emission truck technologies, including hybridization, in-road LSM and OCS; and
- Work with the regional partnership to identify potential funding sources.

In the longer-term, the ports should work with the regional partnership to implement the agreed upon regional strategy, which could include:

- Work on regional zero emission freight strategy implementation, including demonstrating transitional technologies and technologies to extend zero emission truck range;
- Assist with zero emission truck deployment by identifying funding opportunities and assisting with charging, wayside power or hydrogen fueling infrastructure as appropriate; and
- Collaboration on further improvements in battery technologies.

3.6. Zero Emission Options for Cargo Handling at Marine and Intermodal Terminals

Container movement through a marine or intermodal terminal is currently performed by various types of CHE. CHE includes all vehicles and equipment that move cargo, containers, and bulk materials to and from marine vessels, railcars, and on-road drayage trucks.

At existing marine or intermodal terminals, the pathway to zero emission operations is likely to occur through the incremental transition of existing types of CHE and vehicles to zero emission operation, similar to the path recommended for electric short-haul drayage trucks. It is also probable that a terminal that transitions its fleet of conventional CHE to electric operation would at some point consider electrifying the terminal and/or converting some portion of their terminal to a semi-automated container movement system.

3.6.1 Zero Emission Cargo Handling Equipment

Due to the diversity of cargo handling requirements within a marine or intermodal terminal, there is a wide range of specialized CHE, each type of equipment performing a specific function. The majority of the CHE can be classified into one of the following equipment types:

- Forklift
- Rubber Tired Gantry (RTG) crane
- Side Pick
- Other equipment[9]
- Sweeper
- Top Handler
- Yard Tractor

A breakdown of CHE operating at the San Pedro Bay Ports is shown in Table 2[10]:

Table 2: CHE Composition at the San Pedro Bay Ports

CHE Type	POLB		POLA		Combined Ports	
	# of units	% of CHE Fleet	# of units	% of CHE Fleet	# of units	% of CHE Fleet
Forklift	252	19%	538	27%	790	24%
RTG	89	7%	108	5%	197	6%
Side Pick	34	2%	40	2%	74	2%
Sweeper	22	2%	15	1%	37	1%
Top Handler	154	11%	154	8%	308	9%
Yard Tractor	713	52%	962	48%	1,675	50%
Other	94	7%	183	9%	277	8%
Total	1,358	100%	2,000	100%	3,358	100%

[9] Other equipment includes but is not limited to construction-related equipment, non-container moving cranes, miscellaneous warehouse equipment, and utility and support vehicles.

[10] Source: 2009 POLA and POLB Emissions Inventories

The relative contribution of each type of CHE to the emissions at the combined ports is shown in Table 3. Yard tractors that comprise 50% of the CHE fleet account for 51% of total CHE DPM and 42% of total CHE NOx emissions. Top handlers, which comprise only 9% of the total CHE fleet, account for 22% of total CHE DPM and 27% of total CHE NOx emissions. In contrast, forklifts which account for 24% of all CHE represent only 5% of total CHE DPM and 8% of total CHE NOx emissions.

Table 3: Relative Emission Levels of CHE Types at the Combined Ports

CHE Type	DPM (tpy)	% DPM of Total CHE Fleet	NOx (tpy)	% NOx of Total CHE Fleet
Forklift	2	5%	102	8%
RTG	4	9%	142	11%
Side Pick	1	2%	41	3%
Sweeper	0	1%	8	1%
Top Handler	9	22%	350	27%
Yard Tractor	22	51%	560	42%
Other	4	10%	115	9%
Total	42	100%	1,318	100%

3.6.2 Performance Requirements for Cargo Handling Equipment

A challenge with implementing zero emission technologies for CHE is the diversity of CHE duty cycle requirements, which vary by type of equipment. Performance requirements for specific types of CHE are shown below in Table 4:

Table 4: Typical Performance Requirements for Port Cargo Handling Equipment

			POLA			POLB		
CHE Type	Typical Duty Cycle	CHE Operations Description	Engine Size (avg. HP)	Load Factor	Average Hours per Year	Engine Size (avg. HP)	Load Factor	Average Hours per Year
Forklift	Operate two 6.5-hour shifts per day, 5-6 days per week.	Used to move cargo, truck chassis, or other equipment short distances for placement on or removal from stacks	105	0.3	848	106	0.3	426
RTG	Operate two 7-hours shifts, 4 days per week.	Used to stack containers, or move containers on and off yard trucks	543	0.2	1,155	682	0.2	970
Side Pick	Operate two 6.5-hour shifts per day, 5-6 days per week.	Used to stack containers, move containers from one area of the terminal to another, or move containers on and off yard trucks	208	0.59	1,055	181	0.59	602
Sweeper	Operate two 8-hour shifts per day, 5-6 days per week.	Used to clean paved areas in the yard	128	0.68	293	118	0.68	397
Top Handler	Operate two 6.5-hour shifts per day, 5-6 days per week.	Used to stack containers, move containers from one area of the terminal to another, or move containers on and off yard trucks	290	0.59	1,534	294	0.59	1,450
Yard Tractor	Operate two 8-hour shifts per day, 5-6 days per week.	Used to move containers to and from ships or rail, move containers within the terminal, and move containers to and from RTG cranes for placement on or removal from stacks	215	0.39	1,699	189	0.39	1,301
Other	Various special purpose duties	Includes a variety of equipment types including aerial lifts, rail-car movers, and heavy duty off-highway trucks	37 - 401	0.43 - 0.55		37 - 401	0.43 - 0.55	

It is noteworthy that the duty cycle requirements for yard tractors have some similarities to the near-dock/short-haul duty-cycle for on-road drayage trucks discussed in preceding sections. This similarity in operational requirements suggests that zero emission technology solutions that are feasible for short-haul drayage have a high probability of being applicable to yard tractors within a marine terminal.

3.6.3 Technology Status for Zero Emission Cargo Handling Equipment

All of the ship-to-shore gantry cranes in both ports are powered by electricity. In addition, the ports have aggressively advanced technologies that reduce or eliminate emissions from other CHE operating within the terminals. This includes demonstration of bridge technologies on the path towards zero emissions, such as diesel-electric hybrid. These technologies not only provide incremental emission reduction benefits in the near-term, they can provide useful information to benefit the development and demonstration of future advanced technologies. Low emission technology CHE projects undergoing demonstration through TAP are summarized below in Table 5:

Table 5: Interim Technologies Toward Zero Emissions Demonstrated Through TAP

Technology Category	Project	Anticipated Emission Reductions
Hybrid Technologies	Vycon REGEN System for RTGs	25% DPM; 30% NOx; 30% CO2
	Capacity Plug-In Hybrid Yard Tractor	60% CO2
	Diesel-Electric Hybrid Yard Tractor	93% DPM; 5% NOx
	Railpower EcoCrane RTG	75% DPM and NOx
Alternative Fuel Technologies	LNG Yard Tractors (2005 Model Year)	100% DPM; +21% NOx; 18% CO2
	APT Emulsified Biodiesel	40% DPM
Retrofit and Exhaust After-treatment Technologies	Rypos Active Diesel Particulate Filter	85% DPM

In addition, the ports are also conducting demonstrations of zero emission technologies, as identified below:

- Balqon Lead-Acid Battery Yard Tractor;
- Balqon Lithium-Ion Battery Yard Tractor;
- Balqon Lithium-Ion Battery Yard Tractor integrated with a Vision Motor Hydrogen Fuel Cell; and
- Vision Motor Hydrogen Fuel Cell/Plug-In Electric Yard Tractor.

As discussed in Section 3.4.2, the Port of Los Angeles and AQMD contracted with Balqon to develop and demonstrate a battery-electric truck. The Port of Los Angeles has ordered Nautilus E-20 units with lead acid batteries and is currently releasing them in a demonstration program at non-container terminals where the duty cycle is less demanding. The next generation E-20 units are equipped with lithium ion batteries, some with range extending hydrogen fuel cells for on-board charging. These next generation E-20 units will be released for demonstration at a trucking company-based container facility with plans to demonstrate them at marine container terminals thereafter. Vision Motor's Hydrogen Fuel Cell/Plug-In Electric Yard Tractor is currently being produced and is expected to be tested at a trucking company-based container facility in 2011.

Manufacturers of conventional diesel yard tractors have also expressed interest in offering electric versions of their existing product line; thus, it is anticipated that additional manufacturers will enter the electric yard tractor marketplace in the future.

For RTGs, electric conversion kits are commercially available and have been used in other countries. RTGs can be electrified by retrofitting the units with a kit (cable reel, transformer and interface) to allow the RTG to utilize grid electricity. The Port of Los Angeles is currently pursuing an electric RTG crane project with one terminal operator; two terminal operators in Port of Long Beach had initially pursued RTG crane electrification projects and were awarded $2.5 million grants from the port in 2007, however both projects were cancelled due to financial constraints and/or a decision by the terminal operator to wait until the project would better fit into future terminal plans.

Similar to electric RTGs, rail mounted gantry cranes or RMGs, are also powered by electric grid power. RMGs travel forward and backward along a fixed rail. RMGs are currently in use in rail yard operations at ICTF and terminal operations at APL in Port of Los Angeles.

3.6.4 Evaluation of Zero Emission Technologies for Cargo Handling at Marine Terminals

The evaluation criteria introduced in Section 3.3 were applied to individual CHE types at the "vehicle level" to identify and prioritize zero emission CHE opportunities for existing marine and intermodal terminal operations. Note that the evaluation included only those equipment types for which staff had information at this time on electrification or zero emission technology options. As part of recommended next steps, zero emission technologies will be identified and advanced for all CHE types. Note that the "regional scalability" evaluation criterion does not apply when evaluating zero emission options for CHE, since these vehicles are a captive fleet at a terminal. The evaluation results are provided below in Table 6.

Table 6: Evaluation of Marine and Intermodal Terminal Cargo Handling Options

	Zero Emission Cargo Handling Equipment			
Evaluation Criteria	**Yard Tractor**	**RTG**	**RMG**	**Forklift**
Emissions and Health Risk Reduction	Excellent	Excellent	Excellent	Good
Constructability	Excellent	Good	Good	Excellent
Technology Readiness	Satisfactory	Excellent	Excellent	Satisfactory
Operations Compatibility	Good	Good	Satisfactory	Good
Regional Scalability	N/A	N/A	N/A	N/A
Cost and Economic Sustainability	Good	Good	Good	Good
Timeline for Implementation	Satisfactory	Good	Good	Satisfactory

Excellent Good Satisfactory Poor Unacceptable

A discussion regarding CHE relative to each criterion is provided below:

- Emissions and Health Risk Reduction – All of the zero emission CHE offer significant emissions reduction. It should be noted, however, that many of the forklifts already operate on propane, and a few of the smaller forklifts are battery powered. Therefore, the emissions reduction potential for forklifts is slightly less than for the other diesel equipment.

- Constructability – Zero emission yard tractors and forklifts would operate on the existing terminals and would only require installation of electric battery charging capabilities, if necessary. Electric RTGs and RMGs would require construction of electrical infrastructure, potentially guard rail systems to protect the infrastructure and, in the case of RMGs, construction of rail tracks.

- Technology Readiness – Zero emission yard tractors are in the development stage, as battery-electric and zero emission hybrid-electric yard tractor prototypes are undergoing development and demonstration in port-related operations. Zero emission forklifts are commercially available for the smaller horsepower range (~100 hp), but development work is needed to apply zero emission technology to heavy-duty forklifts in port container terminal operations. Electric RTG retrofits, electric RMGs and forklifts are commercially available and have been used in port-related operations.

- Operations Compatibility - Electric yard tractors and forklifts offer a high level of compatibility with ongoing terminal operations and can be seamlessly integrated into a marine or intermodal terminal incrementally. Accommodation will need to be made for recharging, as needed; however a goal of the TAP demonstrations will be to evaluate any impacts on operations from recharging. When integrating electric RTGs and RMGs into operations, some of the current flexibility offered by traditional diesel-powered RTGs will be lost. In particular, the installation of electric infrastructure and rail tracks for RMGs requires that the electric RMGs be fixed to a specific location which will limit the ability to make adjustments to yard configurations. Some terminal operators have stated that this inflexibility is incompatible with their current operations, and therefore further evaluation on how this technology could be integrated into existing operations may be needed in some cases. Converting an RTG to electric requires electrical infrastructure, but it is only semi-fixed and therefore provides greater flexibility for future yard re-configuration. In addition, as an interim measure, the ports are continuing demonstration of low-emission technologies for RTGs that are not converted to a zero emission configuration.

- Cost and Economic Sustainability – In the near term, electric CHE will most likely require incentives to partially offset the higher capital acquisition costs of battery electric vehicles and equipment. From a life cycle cost perspective, it is anticipated that the terminal operators will realize lower operating costs tied to lower fuel costs and lower equipment maintenance costs.

  Electric yard tractors also share common technology and components with electric short-haul drayage trucks; this commonality leverages prior investments and should generate manufacturing economies of scale, reducing future costs for vehicle acquisition. It is also expected that electric drive system designs and components developed for yard tractors can and will be adapted to other types of CHE, such as top handlers and side picks. This transferability will further leverage zero emission technology investments.

- Timeline for Implementation – Electric yard tractors are undergoing demonstration in port duty cycles now and more concepts are anticipated to be demonstrated in the near future. Electric RTGs, RMGs and smaller forklifts are commercially available. Electric RTGs or RMGs are currently being implemented in new or redeveloped terminal projects.

3.6.5 Recommendations for Cargo Handling Equipment

The ports recommend the following near-term course of action:

- Continue to sponsor the demonstration of electric CHE by port tenants in cargo handling operations. Electric yard tractor prototypes are currently under development through the TAP program, and the priority of port staff is to demonstrate the capabilities of electric yard tractor technologies in meeting port duty cycle requirements. These demonstration tests will also need to determine overall integration into operations, including battery charging/fueling requirements. The advanced lithium-ion battery Balqon yard tractor is undergoing preliminary testing and will be delivered for testing in container terminal operations by 3rd quarter 2011. The prototype Vision Motors zero emission yard tractor is also anticipated to be delivered for testing by 3rd quarter 2011. Both units will immediately begin an 18-month demonstration period in accordance with an approved Demonstration and Test Plan. The goal is to have zero emission yard tractors fully developed, tested, and commercially available within the next 2 -3 years.

  The top priority is to bring electric yard tractor technologies successfully through the development and demonstration phase, including operational integration, resulting in the commercial availability of zero emission yard tractors in the near term.

  Advanced yard tractor technologies, such as diesel hybrid electric, have also been successfully demonstrated under the TAP. These technologies have the potential to achieve near-term emission reductions from diesel-fueled yard tractors and can serve as bridge technologies until electric yard tractors are fully commercialized.

  Because battery electric yard tractors are anticipated to carry a cost premium compared to conventional diesel yard tractors, the availability of financial incentives to buy down a portion of the incremental capital cost of the electric technology may be necessary in the near term. Dedicated electric yard tractor recharging infrastructure may also be required and will add additional cost. Costs for equipment maintenance however are expected to be reduced from conventional equipment. To fully or partially offset the incremental cost for zero emission technologies that reduce emissions above and beyond the CARB Cargo Handling Equipment rule, the ports should encourage agencies such as the Department of Energy (DOE), California Energy Commission (CEC), EPA, CARB and AQMD to make financial incentives available.

- Continue to work with terminals operators to select additional zero emission CHE technologies for demonstration through the TAP process, with oversight by the TAC.

- Working with a terminal operator in the Port of Long Beach, the ports commissioned the development of performance specifications for yard tractors. The final specification information, which was completed in 2009, is posted on the ports' CAAP website. The ports continue to work with terminal operators to develop performance specifications for additional equipment types, operational requirements, and integration strategies for zero emission cargo handling equipment.

- Continue to facilitate the electrification of RTGs. Kits that convert diesel generator powered RTG cranes to grid electricity are commercially available. The ports should continue to facilitate implementation of this technology for port terminals, where feasible, through ensuring adequate electrical capacity and infrastructure at the terminals. The ports should also encourage the agencies, such as DOE, CEC, EPA, CARB, and AQMD, to make financial incentives available to offset incremental costs. The ports can also apply for grants from government agencies on behalf of port terminal operators as needed.
- Expansion of RMGs into terminal operations, as feasible and appropriate, should also be encouraged. Typically, because RMGs require installation of rail tracks, implementation of RMGs will be more appropriate during new terminal construction or renovation of existing terminals. The ports are currently requiring electric RTGs or RMGs in new or redeveloped terminal projects.
- As needed, the ports can also apply for grant funding assistance on behalf of terminal operators to support zero emission CHE demonstration and deployment at marine and intermodal terminals. Each port has previously provided this type of support to their terminal operators for equipment retrofit, replacement and repower projects by applying to grant programs that are only available to government entities.

In the longer term, the ports could also:

- Continue to move forward with TAP demonstrations of advanced zero emission technologies for all CHE, including broader operational and durability testing. The ports should pursue the demonstration of electric technology applied to other types of CHE, specifically container top-handlers that comprise 9% of the ports' CHE equipment inventory but account for 22% of total CHE DPM emissions and 27% of total CHE NOx emissions;
- Continue to facilitate electrification of RTGs and RMGs, and work with marine and intermodal terminals to identify additional opportunities for integrating and implementing zero emission terminal operations;
- Promote ongoing improvements in battery technologies through the TAP;
- Assess the need for battery charging or hydrogen fueling station infrastructure with larger-scale zero emission CHE deployment, and assist as needed and appropriate;
- Assist with identifying funding support for purchases of zero emission equipment and/or terminal electrification, which may include applying for grants on behalf of terminal operators.

3.7. Zero Emission Options for Regional Rail Locomotives

The ports understand that locomotive emissions impact communities near the port complex and along goods movement rail corridors within the SoCAB. Thus, there is a compelling need to address locomotive emissions both at the in-port and regional levels. While the challenges presented in adapting zero emission technologies to rail locomotive operations are considerable, they are by no means insurmountable.

The ports, in partnership with rail stakeholders from both government and industry, must develop a recommended course of action to substantially reduce emissions from rail locomotives at both the in-port and regional levels. It is essential that any zero emission rail concept identified for possible implementation be developed and demonstrated with the cooperation and concurrence of several key stakeholders, particularly the U.S Department of Transportation Federal Railroad Administration (FRA) and the Class 1 railroads that serve the ports, BNSF Railway and UP Railroad. Further, it must be understood that due to the complexities associated with zero emission rail technologies, the timeframe for zero emission integration with rail operations is substantially longer compared to technology options for other sources discussed in this report. Therefore, the ports must continue to pursue the CAAP strategies in the interim for reducing rail emissions, even as they work to identify viable and feasible zero emissions options for the long term that could be integrated into railroad operations.

The application of zero emission technologies to rail locomotive operations within and beyond port boundaries is a far more complex task than for short-haul drayage and CHE. First, the technical and programmatic assessments conducted by the ports relative to port-related rail operations revealed that implementation challenges will exist related to right of way entitlements and future track capacity to accommodate optimized or high frequency container moves by rail between marine terminals and near-dock intermodal facilities. Second, the ports' authority as it pertains to rail operations is limited, specifically on the Alameda Corridor and particularly beyond port boundaries. However, despite these challenges, the long-term implementation of zero emission technologies for rail operations must be pursued in cooperation with all stakeholders to address in-port and regional locomotive emissions.

3.7.1 An Overview of Rail Operations at the San Pedro Bay Ports

Port rail emissions represent 5% of the combined ports' total emissions inventory for DPM and 8% of the NOx emissions. Port efforts to further reduce port-related rail emissions remain a main concern. In fact, the effort to utilize best available control technologies to mitigate locomotive emissions is a priority of the ports' TAP.

Railroad operations at the ports are typically described in terms of two different types of operation, line-haul and switching. Line-haul refers to the movement of cargo over long distances (e.g., cross-country) and occurs within the port as the initiation or termination of a line-haul trip, as cargo is either picked up for transport to destinations across the country or is dropped off for shipment overseas. Switching refers to short movements of rail cars, such as in the assembling and disassembling of trains at various locations in and around the ports, sorting of cars of inbound cargo trains for subsequent delivery to marine terminals, and short distance hauling of rail cargo within the port complex.

The ports are served by three rail companies:

- BNSF Railway
- UP Railroad
- Pacific Harbor Line (PHL)

BNSF and UP are designated Class 1 railroads[11] and operate both within and outside of the port boundaries. Both operate national fleets under the regulations and scrutiny imposed by the FRA. PHL is the switcher locomotive operator within the port boundaries, controlled under operating agreements with both ports. Locomotives used for line-haul operations are typically equipped with large, powerful engines of 4,000 horsepower (hp) or more, with each railroad operating a variety of different locomotive models. Switcher locomotives are smaller, typically having one or more engines totaling 1,200 to 3,000 hp.

3.7.2 Ongoing Efforts to Reduce Locomotive Emissions

The 2010 CAAP Update includes measures targeting continued reductions in locomotive emissions. Specifically, CAAP Measure RL3 ("New and Redeveloped Near-Dock Rail Yards") outlines the strategy to achieve significant reductions in locomotive emissions through the accelerated turnover of the existing locomotive fleet, replacing existing locomotives with newer, lower emitting models. The goal of this measure is to have the Class 1 railroads incorporate the cleanest locomotive, CHE, and HDV technologies into near-dock operations. Measure RL3 establishes the goal that the Class 1 locomotive fleet associated with new and redeveloped near-dock rail yards meets a minimum performance requirement of an emissions equivalent of at least 50% Tier 4 line-haul locomotives and 40% Tier 3 line-haul locomotives when operating at the port properties by 2023, to support CARB's published goal of 95% Tier 4 line-haul locomotives serving the ports by 2020. In addition, RL3 will implement idling restrictions, the use of cleaner fuels and evaluation of cleaner locomotive technologies.

[11] The Surface Transportation Board defines a Class I railroad in the United States as "having annual carrier operating revenues of $250 million or more" after adjusting for inflation using a Railroad Freight Price Index developed by the Bureau of Labor Statistics.

Additionally, the ports amended PHL's operating agreements in 2006 to provide funding assistance for the replacement of PHL's existing locomotives with new locomotives meeting Tier 2 emission standards. The locomotives purchased under the amended agreements were delivered during 2007 and 2008; and immediately thereafter, PHL retired the last of the pre-Tier 2 locomotives. Since 2009, PHL's fleet has consisted of 16 Tier 2 locomotives and six "multi-engine genset switcher" locomotives that are powered by three relatively small diesel engines rather than one large engine. These multi-engine genset switcher locomotives use Tier 3 engine technologies. Further, under subsequent amendments to the operating agreements in 2010, PHL is now moving forward with repowering the 16 Tier 2 locomotives with engines that meet even cleaner Tier 3 + standards prior to the end of 2011.

Finally, the ports and UP are participating in an emerging technology demonstration of a Johnson Matthey diesel particulate filter retrofit device for locomotives, anticipated to reduce DPM emissions by over 85%. The project is being funded by a combination of a grant from CARB secured by the ports and TAP funding.

3.7.3 Jurisdictional Authority

The vast majority of line-haul trains bound for destinations outside the port utilize the Alameda Corridor, a 20-mile dedicated rail line running between the San Pedro Bay area and downtown Los Angeles. The ports' ability to impose zero emission requirements on Class 1 locomotives that use the Corridor is substantially limited by the 1988 Alameda Corridor Use and Operating Agreement between the Cities of Los Angeles and Long Beach, ACTA, BNSF and UP.

Beyond the Alameda Corridor Use and Operating Agreement, the ports also have long-term agreements with BNSF and UP that guide track use. These "Use of Tracks" agreements contain long-term conditions that cannot be changed via lease or tariff.

Further, Class 1 locomotives and rail transportation are regulated on a federal level by the EPA, FRA and STB. The EPA adopts emission standards for new and re-manufactured locomotive engines and approves state implementation plans under the Clean Air Act. CARB has entered into voluntary Memorandums of Understanding (MOUs) with the Class 1 railroads to achieve emission and health risk reductions through accelerated turnover of older locomotives with newer, cleaner locomotives and through measures to reduce impacts from railyard operations.

Given the existing agreements and jurisdictional limitations, development and demonstration of zero emission technologies and measures to implement these technologies are most effectively accomplished through a cooperative partnership with the railroads and participating railroad authorities.

3.7.4 Status of Zero Emission Technologies Applicable to Rail Locomotives

As discussed in Section 1, 94% of DPM emissions and 93% of NOx emissions associated with port-related rail operations in 2009 were generated by line haul locomotives. Port-related locomotive emissions are a regional source of air pollution; thus, zero emission options targeting locomotive emissions should be primarily pursued on a regional scale, with the prospect that these options may potentially be applicable to in-port operations.

All zero emission options identified for regional rail use electricity. Rail electrification options that may need to be explored include, but are not limited to:

- Incorporation of LSM technologies into existing rail beds;
- OCS to power electric or dual-mode locomotives; and
- Battery electric tender car.

There are significant operational issues that must be addressed when contemplating the use of rail-related zero emission technologies on a regional scale within the SoCAB, specifically availability of electrification infrastructure and use of dedicated electric-powered locomotives. For example, it must be determined how a dedicated electric-powered locomotive will continue to operate beyond the end of the SoCAB's geographic boundary, if its power source does not continue beyond the SoCAB. The railroads have expressed concerns about any zero emission option that requires a change out of locomotives upon entering or leaving the SoCAB. This presents a serious operational constraint to advancing dedicated electric-powered locomotives as a viable option.

When considering these operational constraints, LSM technology has several potential advantages that warrant further consideration:

- LSM can be adapted to existing rail beds, but does not require electrification of the rails themselves. This propulsion system consists of concrete-encased motor winding modules mounted between rails that provide a magnetic field. Permanent magnets are attached to the bottom of a standard rail car carrying a fully loaded single or double-stacked container. This all-electric approach is free of any exposed high-voltage third rails or OCS wires. Power is provided only to the area of track around each vehicle by using solid-state electronic switches. There is no conflict with conventional diesel locomotives using tracks retrofitted with LSM.
- Conventional rail cars can be used on LSM-equipped track with minimum modifications. A standard rail car is equipped with two wheel "bogies" (the truck that secures the steel wheels and suspension components). Each rail car bogie is modified with the installation of a magnet

module containing arrays of permanent magnets. These magnet arrays interact with the magnetic field induced in the LSM motor modules and provide the thrust to move and stop the rail car. The system as conceived will be capable of propelling very large loads, including multiple double-stacked railcars. The width of the LSM modules and the length of the magnet arrays will be based on the specifics of the application, but hold the potential to propel complete trains. No modifications are required on the locomotives themselves.

- LSM can be integrated into existing rail beds incrementally. On LSM-equipped track, the locomotive can operate in a zero emission mode; then at the end of the LSM line, the diesel locomotive engine can be started and continue in a conventional operations mode;

- LSM is an option that is ready for prototype development and demonstration. A demonstration will provide valuable data to better understand how LSM could apply to regional, and potentially in-port, rail operations.

There are some challenges with LSM however that must also be addressed during any evaluation, especially if the technology will be considered for application between the port terminals and the near-dock rail yards. For example, incorporating automation, or self-propelled rail cars, into an LSM option is currently prohibited by the United States Department of Transportation and the FRA, and no LSM technology has been safety certified by the FRA. Further, the existing rail system within the port complex may not have sufficient capacity to accommodate optimized container routing in either an automated or crewed operation mode. Detailed rail simulation and on-dock railyard capacity analysis, based upon current rail planning, indicated that by 2020, there will be insufficient capacity to handle additional LSM rail car moves to and from near-dock railyards beyond normal movement on on-dock trains and other switching movements. Therefore, a thorough understanding of these issues, and the opportunities to overcome them, is an important aspect of the LSM evaluation.

It is also important to note that consistent with the zero emission technology "process approach" and a commitment to preserve flexibility to allow for integration of future advancements, in addition to LSM, other zero emission rail options will continue to be actively identified, evaluated and demonstrated. The TAP will be utilized for this purpose.

3.7.5 Recommendations for Rail Locomotives

The ports' technical and programmatic screening assessment of zero emission technologies for existing rail operations did not identify any solutions that can reasonably be implemented within the near-term (three years). Thus, implementation of CAAP Measure RL3 discussed in Section 3.7.2 is the recommended primary near-term option to address rail locomotive emissions. *Therefore, for near-term in-port and near-dock rail emission reductions, the ports should continue efforts to reduce switch and line-haul locomotive DPM and NOx emissions through implementation of CAAP Measure RL3.*

Both BNSF Railway and UP Railroad have proposed projects forthcoming that will require new or re-negotiated leases. The ports have adopted policies that their leases shall be compliant with the CAAP, and the Boards of Harbor Commissioners have discretion at the time of lease approval to include among the negotiated lease conditions, CAAP Measure RL3 as a lease condition. The Boards have discretion to include other lease conditions, such as a provision that the Class 1 railroads work with the ports to jointly advance zero emission technology demonstrations, and evaluate new feasible technologies for implementation e.g. every seven years (lease reopener). Concurrent with technology demonstrations, collaboration with the railroads and other regional transportation stakeholders should be initiated to identify and better define issues and challenges to implementing zero emission technologies along regional rail corridors from in-port to the edge of the SoCAB.

As regards rail-related zero emission technologies, there is considerable interest to assess the technical feasibility and programmatic viability of applying LSM technology to existing rail infrastructure. AQMD is currently developing a proposal with General Atomics (GA) for demonstration of LSM technology on conventional rail tracks with a single rail car at GA's test facility located in San Diego. The proposed Phase 1 demonstration, or Proof of Concept, is expected to be initiated by 4th Quarter 2011 and would be conducted over an 18-month period. Other partners in this demonstration project could include the Lawrence Livermore National Laboratory and the Center for Commercial Deployment of Transportation Technologies (CCDoTT).

It is envisioned that this first phase Proof of Concept demonstration would be followed by a second phase, 18-month demonstration, with multiple railcars at a rail research and development testing site that can provide FRA certification. The FRA and American Association of Railroads jointly sponsored Transportation Technology Center (TTC) in Pueblo, Colorado offers such a testing site and the Ports, AQMD, and CCDOTT have had exploratory discussions with TTC. To provide technical input and consistency, TTC may participate as a technical observer/advisor in the Phase 1 test at the GA facility.

Staff recommends that discussions continue with all involved parties regarding a near term Proof of Concept demonstration of LSM technology at an offsite test facility. As the proposed demonstration project matures, a staff recommendation for participating in the project as a stakeholder will be brought forward to each port's Board of Harbor Commissioners for consideration, which may include financial participation. It is anticipated that this recommendation will be brought forward to the Boards within the next few months.

Further, if the Phase 1 testing proves that the LSM technology is promising, the ports could participate in the Phase 2 demonstration of the LSM technology applied to multiple rail cars, as appropriate.

The ports should also collaborate with the rail companies and other stakeholders to further evaluate additional zero emission rail technologies, including LSM, OCS, and a battery electric tender car.

In the longer term, beyond three years, the ports should continue to participate, with a stakeholder collaborative, in existing or proposed zero emission rail demonstration projects, as appropriate; continue to collaborate with rail companies and other stakeholders to evaluate strategies for integrating and implementing zero emission technologies into port-related rail operations on a voluntary basis; and work with stakeholders at the local, state and federal levels to secure funding for zero emission rail technologies.

4. Conclusions and Recommendations

As emphasized throughout this report, there is no single off-the-shelf technology or stand-alone strategy to achieve zero emissions at the ports. Instead, attaining zero emission port-related operations will require multiple pathways of action, strong collaborations and regional partnerships, and support – technical, operational and financial – to advance technological innovation and evolution. It is also a dynamic and ongoing process, a framework approach to transition to zero emissions starting with options that can be supported today.

The roadmap defined in this paper is ambitious. It requires near-term commitments and longer term actions from a broad cross-section of stakeholders. Most of all, this roadmap requires flexibility to accommodate new technologies and approaches alongside a commitment to the end goal – achieving the San Pedro Bay Standards – while addressing and overcoming the myriad challenges identified in this report. If successful, however, this roadmap has the potential to dramatically improve air quality for local communities and throughout the region.

The recommendations proposed here – targeting short- and medium-haul drayage trucks, cargo-handling equipment, and rail – adhere to the key principles identified in Section 1.

Recommended near-term and longer term actions are summarized in Table 7.

Table 7: Recommendations for Zero Emission Technology Implementation

Timeline	Source Category	Actions
Near Term **(within 3 years)**	On-Road Drayage	Conduct Technology Advancement Program (TAP) demonstrations of Vision Motors hybrid electric/hydrogen fuel cell and Balqon lithium-ion battery zero emission drayage truck technologies in short-haul port-related operations following approved testing protocols and within specified timelines. Both manufacturers will deliver trucks for testing by 3rd Quarter 2011. Industry representatives will participate in these demonstrations in an advisory capacity, along with the TAP Technical Advisory Committee (TAC), which includes the ports, Environmental Protection Agency (EPA), California Air Resources Board (CARB) and South Coast Air Quality Management District (AQMD); Select additional zero emission truck technologies for demonstration through the TAP process, with input from industry and the TAP TAC; Seek grant funding assistance and industry partnerships to support zero emission truck demonstration and deployment, as needed; Establish regional partnership with the Los Angeles Metropolitan Transportation Authority, Southern California Association of Governments, Gateway Cities, South Coast Air Quality Management District (AQMD), and others. Work together to define regional zero emission freight transport needs and develop criteria for evaluating options for moving forward with zero emission truck technologies on a regional scale; Working with the regional partnership, identify and evaluate specific range extension options for zero emission truck technologies, including hybridization, in-road LSM, and overhead catenary; Work with the regional collaborative to identify potential funding sources.

Timeline	Source Category	Actions
Near Term (within 3 years)	Cargo Handling Equipment	Conduct TAP demonstrations of Vision Motors hybrid electric/hydrogen fuel cell and Balqon lithium-ion battery zero emission yard tractor technologies in port-related operations following approved testing protocols and within specified timelines. Both manufacturers will deliver yard tractors for testing by 3rd Quarter 2011; Working with terminal operators, select additional zero emission cargo handling equipment technologies for demonstration through the TAP process, with TAC oversight; Working with terminal operators, develop performance specifications, operational requirements, and integration strategies for zero emission cargo handling equipment; Continue to facilitate electrification of RTGs and RMGs by ensuring adequate electrical capacity is available at marine terminals and require their use in new and redeveloped terminal projects; Apply for grant funding assistance to support zero emission cargo handling equipment demonstration and deployment at marine terminals, as needed.
	Rail Locomotives	Participate (with AQMD, the Center for Commercial Deployment of Transportation Technologies, and other stakeholders) in a proposed Proof of Concept demonstration of LSM technology applied to a single rail car test at the General Atomics facility in San Diego. The project is anticipated to be initiated by 4th Quarter 2011; Collaborate with rail companies and other stakeholders to further evaluate zero emission rail technologies, including LSM, overhead catenary, and battery electric tender car; As appropriate, participate in a Phase 2 demonstration of LSM technology applied to multiple rail cars. The phase 2 test would be conducted at a testing center equipped to provide Federal Railroad Administration certification, such as the Transportation Technology Center rail test site in Pueblo, Colorado.

Timeline	Source Category	Actions
Longer Term (>3 years)	On-Road Drayage	Conduct broader operational and durability demonstration testing of advanced zero emission drayage truck technologies in short-haul port-related operations, as needed; Working with industry, evaluate operational compatibility of larger-scale zero emission truck deployment; Work with regional partnership on regional zero emission freight strategy implementation, and on demonstration projects for transitional technologies and technologies to extend zero emission truck range, including hybridization, in-road LSM, and overhead catenary; Assist with zero emission truck deployment by identifying funding opportunities and assisting with charging, wayside power or hydrogen fueling infrastructure as appropriate; Promote on-going improvements in battery technologies through TAP.
	Cargo Handling Equipment	Conduct broader operational and durability demonstration testing of advanced zero emission technologies for all cargo handling equipment, as needed; Assist with zero emission equipment deployment by identifying funding opportunities and assisting with charging or hydrogen fueling infrastructure as appropriate; Promote on-going improvements in battery technologies through TAP; Continue to facilitate electrification of RTGs and RMGs, and work with marine terminals to identify additional opportunities for integrating and implementing zero emission terminal operations.
	Rail Locomotives	Continue to participate, with a stakeholder collaborative, in existing or proposed zero emission rail demonstration projects, as appropriate; Continue to collaborate with rail companies and other stakeholders to evaluate strategies for integrating and implementing zero emission technologies into port-related rail operations; Work with stakeholders to secure funding for zero emission rail technologies.

Attachments from Comment Letter 107

long beach unified school district

RESOLUTION NO. 011712-A

A RESOLUTION OF THE GOVERNING BOARD OF EDUCATION OF THE LONG BEACH UNIFIED SCHOOL DISTRICT OPPOSING CERTIFICATION OF THE SOUTHERN CALIFORNIA INTERNATIONAL GATEWAY FACILITY ENVIRONMENTAL IMPACT REPORT AS CURRENTLY CIRCULATED BY THE PORT OF LOS ANGELES

WHEREAS, the Port of Los Angeles has prepared a Draft Environmental Impact Report (EIR) (September 2011) for the Southern California International Gateway (SCIG) Project which proposes the development of 153 acres of new and substantially expanded intermodal railyard operations that would transfer containerized cargo between trucks and railcars; and

WHEREAS, in accordance with the California Environmental Quality Act, the District has the right to evaluate and comment on the EIR; and

WHEREAS, the SCIG Project is in a location close to sensitive receptors that will adversely affect the District's students and staff as nearby schools include Webster Elementary, Garfield Elementary School, Muir Elementary School, Stephens Middle School, Hudson K-8 School, Cabrillo High School, Reid High School, and Bethune Transitional School; and

WHEREAS, the SCIG Project EIR fails to adequately disclose significant project impacts, including impacts to District schools, staff, and students, because the EIR analysis is predicated upon illusory baseline conditions that mislead the public as to the reality of the impacts, and the EIR does not use established cancer risk factors that account for the greater sensitivity of students to toxic air contaminants; and

WHEREAS, the SCIG Project EIR does not adequately address or mitigate noise, traffic, air quality, and human health risk impacts to schools and other sensitive receptors, fails to adequately evaluate reasonable alternatives to the proposed Project, and fails to provide sufficient evidence that the zero emissions alternative is infeasible; and

WHEREAS, the SCIG Project EIR fails to adequately and accurately assess the cumulative impacts of the SCIG project in connection with other substantial development projects that will generate cumulative emissions that affect the District's schools, students and staff; and

WHEREAS, it is critical to the District as a policy matter to be sure that the emissions and other impacts of development projects on the District's schools, students, and staff are fully disclosed and mitigated, and

WHEREAS, the inadequacies of the EIR prevent the District from evaluating the true environmental consequences of the SCIG Project upon nearby school facilities and making a determination on whether to support or oppose the project.

NOW, THEREFORE, THE BOARD OF EDUCATION OF THE LONG BEACH UNIFIED SCHOOL DISTRICT DOES HEREBY RESOLVE, DETERMINE AND ORDER AS FOLLOWS:

Section 1. That the Board does hereby find and determine that the foregoing recitals and determinations are true and correct.

Section 2. That the Board of the District hereby formally opposes certification of the SCIG project EIR in its current form, and requests recirculation after completion of substantial revisions to ensure it adequately evaluates the environmental impacts on District students, staff and facilities.

ADOPTED, SIGNED AND APPROVED, this **17th day of January, 2012.**

BOARD OF EDUCATION OF THE LONG BEACH UNIFIED SCHOOL DISTRICT OF LOS ANGELES COUNTY, CALIFORNIA

By: ______________________________
President

By: ______________________________
Vice President

By: ______________________________
Member

By: ______________________________
Member

By: ______________________________
Member

STATE OF CALIFORNIA)
) ss.
COUNTY OF LOS ANGELES)

I, Christopher Steinhauser, Secretary, Board of Education of the Long Beach Unified School District, do hereby certify that the foregoing Resolution was duly adopted by the Board of Education of such District at a regular meeting of said Board held on the 17th day of January, 2012, at which a quorum of such Board was present and acting throughout and for which notice and an agenda was prepared and posted as required by law and at which meeting all of the members of such Board had due notice and that at such meeting the attached resolution was adopted by the following vote:

AYES: 3

NOES: 0

ABSTAIN: 0

ABSENT: 2

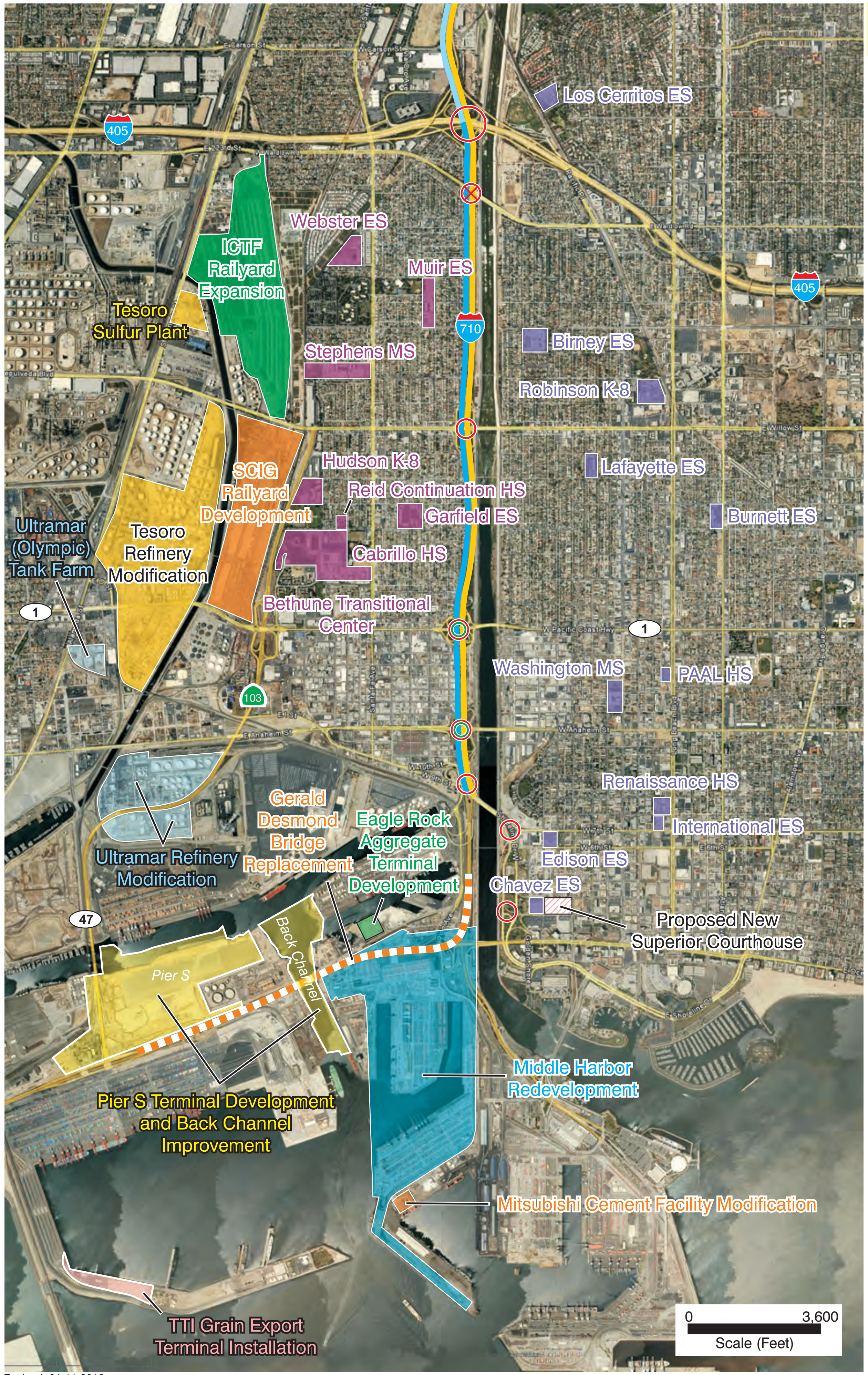
Secretary, Board of Education of the Long Beach Unified School District

STATE OF CALIFORNIA)
) ss.
COUNTY OF LOS ANGELES)

I, Christopher Steinhauser, Secretary, Board of Education of the Long Beach Unified School District do hereby certify that the foregoing is a true and correct copy of Resolution No. 011712-A, which was duly adopted by the Board of Education of the Long Beach Unified School District at a meeting thereof on the 17th day of January, 2012.

Secretary, Board of Education of the Long Beach Unified School District

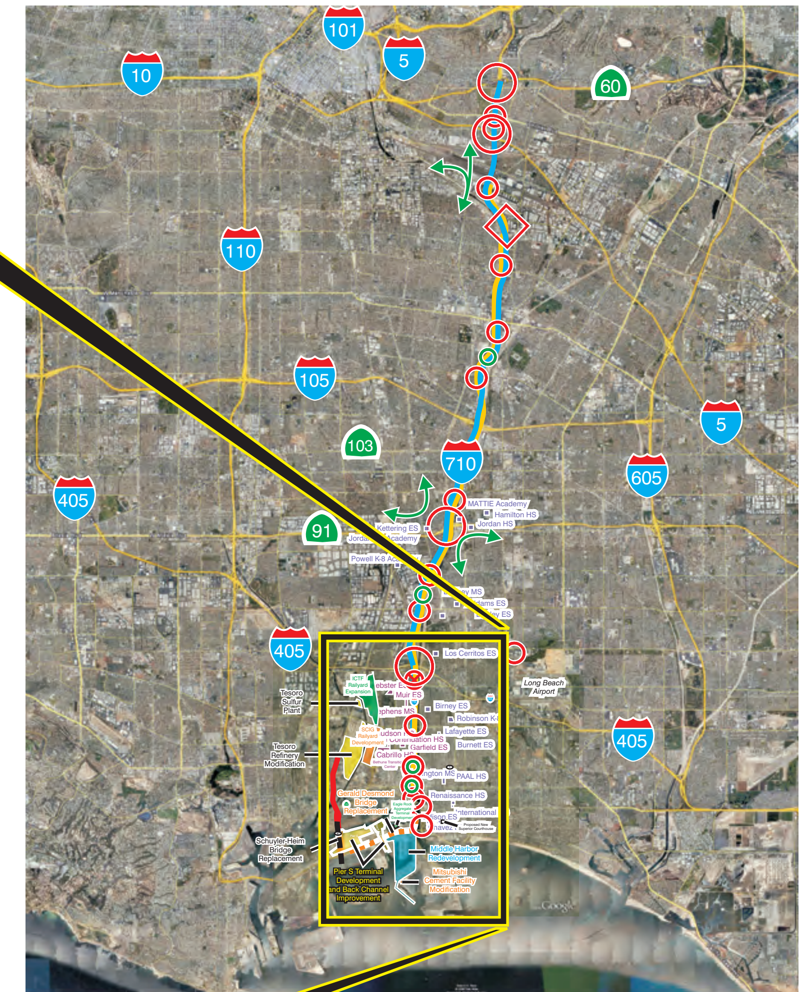
Major Port-Area Projects and Nearby LBUSD Schools



Revised: 01-11-2012

LEGEND

- Schuyler-Heim Bridge Replacement Project
- Alternative 1: SR-47 Expressway to Alameda Corridor (Schuyler-HeimBridge Replacement Project)
- Gerald Desmond Bridge Replacement Project
- Add One Mixed Flow Lane (Each Direction) (I-710 Freeway Corridor Project)
- Add Two Mixed Flow Lanes (Each Direction) (I-710 Freeway Corridor Project)
- Exclusive Truck Facility (I-710 Freeway Corridor Project)
- Interchange Improvement (I-710 Freeway Corridor Project)
- New Interchange (I-710 Freeway Corridor Project)
- Eliminate Interchange (I-710 Freeway Corridor Project)
- Truck Ramps (I-710 Freeway Corridor Project)
- Truck Ingress/Egress (I-710 Freeway Corridor Project)
- Schools (West of I-710)
- Schools (East of I-710)

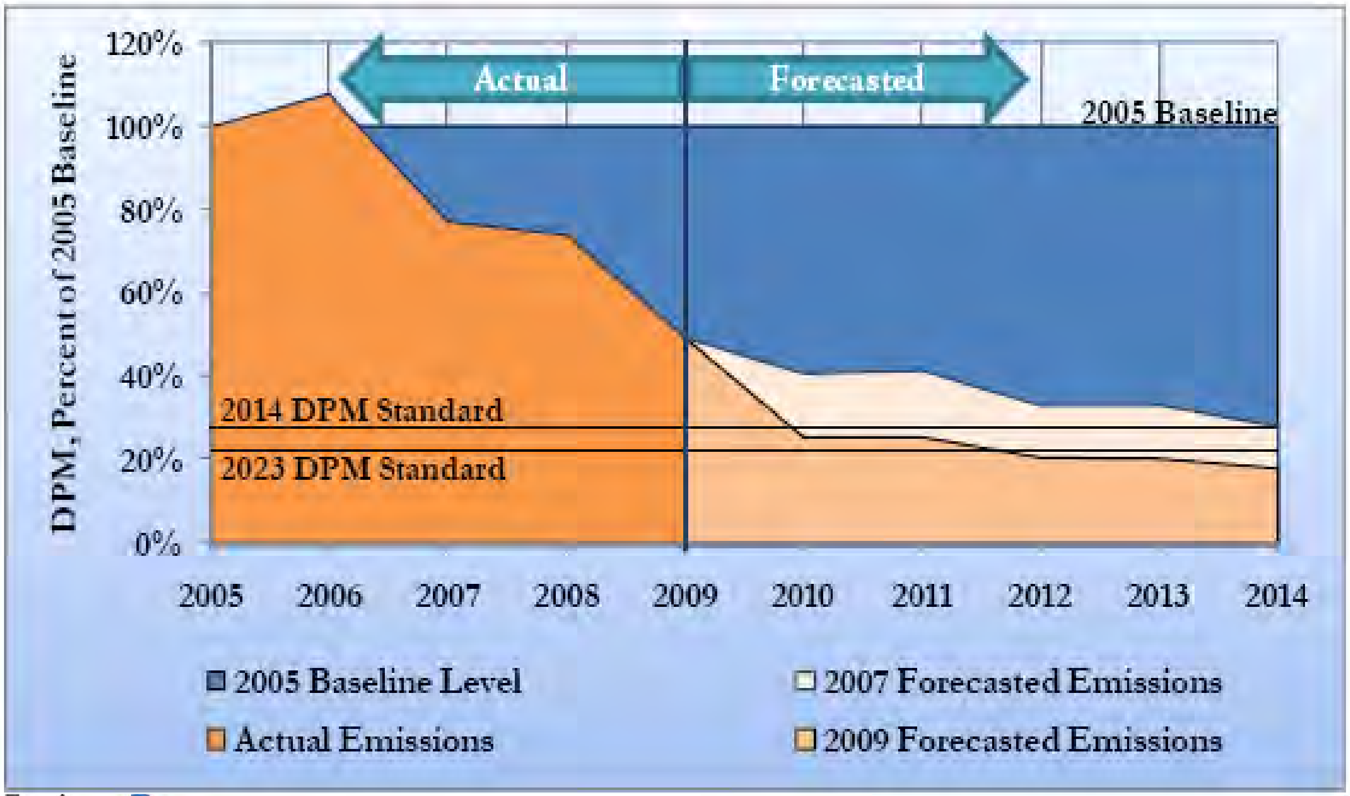


0 5
Scale (Miles)

Ports of Los Angeles and Long Beach Measurements of Diesel Particulate Matter (DMP)

Actual (2005 thru 2009) and Forecasted (2010 thru 2014)

Figure ES.1: DPM Progress To Date & Forecasted Benefits



long beach unified school district

Long Beach Unified School District
BUSINESS DEPARTMENT - Business Services
Facilities Development & Planning Branch
2425 Webster Ave., Long Beach, CA 90810
Phone (562) 997-7550 FAX (562) 595-8644

December 14, 2005

Via Hand Delivery, Fax and U.S. Mail

Ralph G. Appy, Ph.D.
Director of Environmental Management
Port of Los Angeles
425 S. Palos Verdes Street
San Pedro, CA 90733-0151

Subject: Comments on Southern California International Gateway Project (Notice of Preparation)

Dear Dr. Appy:

The Long Beach Unified School District ("District") appreciates the opportunity to comment on the Notice of Preparation ("NOP") prepared for the proposed Southern California International Gateway Project ("Project") by the Port of Los Angeles/City of Los Angeles Harbor Department ("Port"). As the Port may be aware, the District is statutorily required to provide safe and clean school facilities and to provide a high quality public education to students within its boundaries. While the District was originally established in 1885 with fewer than a dozen students meeting in a borrowed tent, the District is now fully responsible for providing school facilities and public education services to more than 95,000 students in 95 public schools in the cities of Long Beach, Lakewood, Signal Hill, and Avalon on Catalina Island. It is the third largest school district in the state of California and employs more than 8,000 teachers and staff, making it the largest employer in the City of Long Beach.

In addition to establishing high standards of academic excellence for its students, the District is committed to providing a safe environment and school facilities for its students and employees. Thus, the District's primary concern in its review of the NOP is to distinguish the environmental impacts which must be properly addressed, analyzed, and mitigated to assure an environment conducive to learning. This letter, therefore, identifies Project impacts which may effect the health, safety and welfare of the students and staff of schools located closest to the proposed Project facilities. The Project EIR must address all possible future impacts on the District, including the District's ability to develop new school facilities and/or expand existing schools in accordance with state mandated requirements.

Overview of Potential Project Impacts on School Facilities

The proposed Project described in the NOP is generally bounded by the Terminal Island Freeway to the east, Sepulveda Boulevard to the north, the Dominguez Channel to the west, and Pacific Coast Highway to the south and portions of the Project would be located in the Cities of Los Angeles, Carson, and Long Beach. The proposed Project consists of a near-dock rail loading and unloading facility to facilitate the movement of container freight in and out of the Port by rail. The District understands that completion of the proposed Project will allow the Port to accommodate the increased rail and truck traffic associated with the existing and future levels of containerized freight the Port plans on handling.

Based on the District's review of the NOP and the Project area, the District believes that there are at least seven schools, a Child Development Center and a maintenance facility currently operating in the vicinity of the Project site and/or planned Project facilities/operations. These school facilities are listed below and are all within less than one mile of the Project or portions thereof, with the closest school located only 210-feet away (see attached Figure 1):

1. Webster Elementary School – 1755 W. 32nd Way
2. Stephens Middle School – 1830 W. Columbus Street
3. Cabrillo High School – 2001 Santa Fe Avenue
4. Hudson Middle School (& Maintenance Facility) – 2335 Webster Avenue
5. Reid High School – 2152 W. Hill Street
6. Garfield Elementary School – 2240 Baltic Avenue
7. Muir Elementary School – 3038 Delta Avenue
8. Bethune Transitional Center (school for homeless students) – 2041 San Gabriel Avenue
9. Child Development Center – 2209 Seabright Avenue

Given the proximity of the Project to the above described schools, the District is very concerned that Project implementation could have a number of potentially significant direct and indirect impacts on the District's school facilities identified above, as well as the students and staff using these facilities. The District will provide its specific concerns in greater detail below, but the District is particularly concerned that the EIR analyze, address, and mitigate any potentially significant impacts associated with the following:

1. Hazardous air emissions associated with the rail yard, increased rail operations, and additional truck traffic from the Project.

2. Noise associated with the rail yard, increased rail operations, and additional truck traffic from the Project.

3. Public health and safety issues associated with spills, leaks, or other accidents from rail or truck traffic as well as any pipelines within the vicinity of District facilities.

4. Traffic impacts associated with additional truck traffic to and from the Project site generating health and safety issues, such as additional air pollution and increased traffic on routes to and from school sites that students may utilize.

Potential Mitigation Measures

In order to ensure none of the above described Project impacts rise to a potentially significant level, the District suggests the EIR analyze the following potential mitigation measures to offset such impacts:

1. Construction of gymnasiums/multipurpose rooms at schools currently without such facilities so that District students and staff have indoor facilities for exercise and other activities to avoid hazardous emissions or unhealthful air quality.

2. Construction of enclosed lunchroom facilities so that District students and staff have indoor facilities for lunch and other activities to avoid hazardous emissions or unhealthful air quality.

3. Improvements to District air conditioning/filtration units at schools, which do not currently have sufficiently modern or appropriate equipment necessary to ensure adequate indoor air quality.

4. Construction of sound barriers/installation of dual-paned windows to offset noise impacts to potentially impacted schools.

5. Construction or improvement of rail and/or traffic signals and crossings to ensure the safety of students en route to school facilities given the potential increased traffic associated with the Project.

Specific Concerns

In the paragraphs that follow, the District describes the specific concerns it has concerning the Project's potential environmental, health and safety impacts and requests that the Port thoroughly address these issues in the upcoming EIR. The EIR should fully recognize that schools must be treated as a sensitive land use given the concentration of young children within and around these facilities for many hours of the school day and during after-school activities. In addition, students themselves must be treated as sensitive receptors given the disproportionate impacts certain pollutants have on children.

Secondly, the District requests that the EIR recognize the unique nature of school facilities under California law. Schools are one of the most protected and heavily regulated land uses. The development of new schools and expansion and modernization of existing schools trigger a myriad of special regulatory requirements for the District that are enforced by a variety of state agencies, which makes finding an adequate school site, and/or expanding an existing school site challenging. These regulations include review and approval by the California Department of Education, the Department of Toxic Substances Control and various other agencies, and often trigger special studies to confirm that stringent health and safety standards are met. Such studies may involve various agency consultations and oversight and the use of rigorous study protocols. This very high level of review creates great difficulty in constructing school facilities. Therefore, the District is very concerned that the proposed Project may subsequently preclude it from upgrading or expanding the schools in the vicinity of the Project described above. These statutorily proscribed site constraints may also make it impossible to find new or replacement school sites in this community after the Project is complete.

Title 5 and Statutory School Siting Issues

The District requests that the EIR evaluate the Project's potential direct and indirect impacts on nearby school facilities in conformance with the school siting requirements established in Title 5, California Code of Regulations (CCR), the Education Code, and the Public Resources Code. If the Project, or any portion thereof, involves the activities described below, the EIR must contain the appropriate study including a level of analysis sufficient to satisfy the state agencies with regulatory authority over the District. To accomplish this level of analysis, the District recommends that the Port analyze Project impacts on District facilities and students as though it were the District. In other words, if a rail line is proposed to be sited within 1,500 feet of school site, the Port should conduct a comparable safety study to that which would be required of the District if it proposed placing a school site within 1,500 feet of the same rail line. Please ensure that the EIR evaluates not only the relationship and proximity of the main components of the Project to the District's school facilities, but also any infrastructure or utilities that would extend to the Project site (especially power lines and pipelines) or other support facilities.

For the Port's reference, Section 14010 of Title 5, CCR contains the following special criteria for potential hazards in the vicinity of school sites:

a. The property line of a school site even if it is a joint use agreement shall be at least the following distance from the edge of respective power line easements: (1) 100 feet for 50-133 kV line; (2) 150 feet for 220-230 kV line; and (3) 350 feet for 500-550 kV line.

b. If the proposed site is within 1,500 feet of a railroad track easement, a safety study shall be done by a competent professional trained in assessing cargo manifests, frequency, speed, and schedule of railroad traffic, grade, curves, type and condition of track need for sound or safety barriers, need for pedestrian and vehicle safeguards at railroad crossings, presence of high pressure gas lines near the tracks that could rupture in the event of a derailment, preparation of an evacuation plan. In addition to the analysis, possible and reasonable mitigation measures must be identified.

c. The site shall not be adjacent to a road or freeway that any site-related traffic and sound level studies have determined will have safety problems or sound levels, which adversely affect the educational program.

d. Pursuant to Education Code sections 17212 and 17212.5, the site shall not contain an active earthquake fault or fault trace.

e. Pursuant to Education Code sections 17212 and 17212.5, the site is not within an area of flood or dam flood inundation unless the cost of mitigating the flood or inundation impact is reasonable.

f. The site shall not be located near an above-ground water or fuel storage tank or within 1500 feet of the easement of an above ground or underground pipeline that can pose a safety hazard as determined by a risk analysis study conducted by a competent professional, which may include certification from a local public utility commission

g. The site is not subject to moderate to high liquefaction or landslides.

h. The shape of the site shall have a proportionate length to width ratio to accommodate the building layout, parking and playfields that can be safely supervised and does not exceed the allowed passing time to classes for the district.

i. The site shall be easily accessible from arterial roads and shall allow minimum peripheral visibility from the planned driveways in accordance with the Sight Distance Standards established in the "Highway Design Manual," Table 201.1, published by the Department of Transportation, July 1, 1990 edition, and incorporated into this section by reference.

j. The site shall not be on major arterial streets with a heavy traffic pattern as determined by site-related traffic studies including those that require student crossings unless mitigation of traffic hazards and a plan for the safe arrival and departure of students appropriate to the grade level has been provided.

k. Existing or proposed zoning of the surrounding properties shall be compatible with schools in that it would not pose a potential health or safety risk to students or staff in accordance with Education Code Section 17213 and Government Code Section 65402 and available studies of traffic surrounding the site.

l. The site shall be located within the proposed attendance area to encourage student walking and avoid extensive bussing unless bussing is used to promote ethnic diversity.

m. The site shall be selected to promote joint use of parks, libraries, museums and other public services, the acreage of which may be included as part of the recommended acreage as stated in subsection (a) of this section.

n. The site shall be conveniently located for public services including but not limited to fire protection, police protection, public transit and trash disposal whenever feasible.

o. The district shall consider environmental factors of light, wind, noise, aesthetics, and air pollution in its site selection process.

p. Easements on or adjacent to the site shall not restrict access or building placement.

q. If the proposed site is on or within 2,000 feet of a significant disposal of hazardous waste, the school district shall contact the Department of Toxic Substances Control for a determination of whether the property should be considered a Hazardous Waste Property or Border Zone Property.

The District also requests the Port and the EIR consider and include appropriate analysis of the rail operations issues described in Education Code Sections 17212.2 and the hazardous materials requirements of Public Resources Code Section 21151.4 and 21151.8.

Hazardous Air Emissions

1. The Initial Study indicates that the proposed Project would divert truck traffic using nearby local freeways (e.g., 710 Freeway) to a facility in closer proximity to the Port, which would ease traffic conditions on local freeways and reduce air quality impacts. While the proposed Project may achieve a positive overall environmental impact for the region as stated in the Initial Study, the proposed Project would substantially decrease localized air quality for the nearby population, including school population, in the Project area. The proposed Project would place more traffic on local roadways, primarily on Pacific Coast Highway. In addition, the District anticipates that the increased efficiency of the loading and transport freight operations at the Port will lead to additional ship, train, and vehicle trips, thereby increasing the related air pollutant emissions. Therefore, the EIR should identify all hazardous air emission sources and their impacts on the school population, including the proximity of District school facilities to the potential emission sources. Specifically, the EIR should consider the following issues:

1a. The EIR must clarify how any additional vessel traffic resulting from the proposed Project would be mitigated and describe how vessel traffic would be monitored. The Initial Study states that the proposed Project would not result in changes in vessel traffic levels or patterns to create substantial safety risks. However, the District believes that increases in the processing of freight would lead to accepting more freight from additional ships. If it is determined that the proposed Project may lead to additional ships utilizing the port facilities, air pollutant emissions from these additional ships must be accounted for in both the emissions inventory and health risk analysis. The EIR must describe how potentially improved handling of containerized cargo would improve vessel traffic flow and identify how it relates to the emissions. (We suggest you review a recent Court of Appeals case on the relationship between infrastructure sizing and its impact on growth. *See Laub v. Davis*, 2005 DJDAR 12079 (October 7, 2005)).

1b. The EIR should include a health risk analysis that considers the potential health impacts from both the exterior and interior exposure of students to train related emissions in combination with existing port emissions. The proposed Project would involve an increase in the use of trains along the Union Pacific Railroad (UPRR) to transport freight as opposed to trucks. In addition, the proposed track extension would locate emission sources closer to the existing schools. Therefore, the healthrisk analysis performed for the Project needs to consider the both the exterior and interior exposure of students.

1c. The EIR must include a health risk analysis that evaluates the potential health risk for all sources that may potentially affect the health of the students within the District including appropriate air dispersion modeling (as described in Education Code Section 17213(c)(2)(C)). The proposed Project has the potential to increase localized concentrations of air pollutants in the vicinity of the Project site. Though Project-related air pollutant concentrations will be evaluated within the technical studies conducted under CEQA, the District is concerned about the cumulative effects of air pollutant concentrations on the health of the students at District schools. The California Air Resources Board's *Diesel Particulate Matter Exposure Assessment Study for the Ports of Los Angeles and Long Beach* states that there are already significant health risks associated with existing port related air pollutant concentrations. The District is concerned that the Project would degrade the air quality conditions at District schools.

1d. The EIR must include a health risk analysis that evaluates potential impacts on indoor air quality at the District's school facilities and whether the use of High Efficiency Particulate Air (HEPA) filter systems at District schools would improve indoor air quality. The District is concerned that air pollutant concentrations may adversely affect the indoor air quality at District schools.

1e. The EIR must include an evaluation of how the potential construction of gymnasiums/multipurpose room with HEPA filter systems could improve the air quality of students and faculty. The provision of gymnasiums/multipurpose room would provide an alternative to exercising outside where air quality is considered poor due to the Port and Port of Long Beach being the largest single source of PM^{10} within the south coast air basin. The provision of gymnasiums/multipurpose room as mitigation measures is essential because children and the elderly represent the most vulnerable segment of our population and children have higher respiratory rates due to their level of physical activity.

1f. The California Air Resources Board (CARB) has published the *Diesel Particulate Matter Exposure Assessment Study for the Ports of Los Angeles and Long Beach.* This Study has identified current operations at the Ports of Long Beach and Los Angeles as major sources of PM10. It also stated "Growth forecasts predict that trade at the POLA and POLB will triple by 2020, resulting in a 60 percent increase in diesel PM emissions from current levels unless further controls are enacted." This increase in emissions and associated health risk due to the increased port activities must also be evaluated within the EIR.

1g. The proposed Project may expose District students and staff to unhealthful air quality conditions. We request that the Draft EIR address these serious concerns and identify specific mitigation measures to reduce all such impacts to less than significant.

Noise and Vibration Impacts

2. The EIR must include noise and vibration evaluation at each of the school sites potentially impacted by the proposed Project. The existing schools currently experience extensive noise from trains (especially along the San Pedro Branch line that extends along the eastern boundary of the Project site) and trucks associated with the existing industrial activities. The increased number of train and vehicle trips would contribute to the increased noise and vibration impacts for the existing schools. The typical approach for the assessment of noise uses a 24-hour CNEL noise metric which averages noise levels from train activity with periods of no train activity over a 24-hour period. This approach would understate the impact of train noise which is most evident during single train passings. The noise impact assessment should evaluate the noise impact from single train events and not be averaged with periods of no train activity. This single event train noise impact assessment needs to include a discussion of how train noise would result in speech interference at 45 dBA Leq. Increasing the frequency of train operations may lead to a greater number of occurrences of interference of speech intelligibility of students and faculty. This increase in noise may restrict the District's ability to expand and improve the existing schools. Noise analysis should identify these sensitive receptors and evaluate site specific impacts and mitigation for each school. The EIR should identify all feasible mitigation measures necessary and appropriate to reduce noise and vibration impacts to any of the District's school facilities potentially impacted by the Project.

3. The noise impact evaluation also needs to consider potential mitigation measures such as a perimeter sound/barrier wall along the Terminal Island freeway at Hudson to protect the site from noise, traffic, and viewing activities at the facility. Other types of mitigation measures that should be considered are removal of at-grade crossings between the railroad and streets, use of quadgate railroad crossing systems, trenches to reduce vibration impacts, construction of gymnasiums to provide a quiet athletic environment and structural acoustic improvements at schools.

Traffic and Transportation:

4. In page 34 of the IS, it is indicated that the proposed Project might result in the increased use and traffic on the existing streets in the Project area, which could increase hazards at pedestrian crossings in the vicinity of the District's schools. These crossings are already very busy and pose potential safety hazards to the District's students. The increased traffic from the Project may create potentially significant impacts because the proposed Project would exacerbate the current situation. Further degradation of the current hazardous condition would constitute a potentially significant impact. The traffic study should identify existing and future hazardous intersections in the Project vicinity and conduct proper analysis.

Public Health & Safety:

5. The EIR should identify any high-pressurized gas or liquid petroleum lines within the Project site and evaluate the risk of rupturing. The District is concerned about the high pressure gas or liquid petroleum pipelines within the railroad easements in the Project vicinity. The District is concerned that the overall increase in rail traffic would also increase the probability of derailment and pipeline rupture.

6. The EIR should identify potential safety risks related to transport/handling of hazardous materials such as potential for spill, release, leak, and explosion in case of derailment or accident. The District anticipates that an increase in rail usage would also increase the quantity and volume of hazardous materials being transported to and from the Project site.

7. The EIR should identify any overhead or underground transmission power lines above 50 kV. The District is concerned with the current and future electric power sources in association with the EMF effect. The EIR should also identify any plans for relocation, construction, and/or any proposed voltage increase for existing transmission lines.

Cumulative Impacts:

8. The EIR must include a cumulative impacts analysis. The District is concerned about the cumulative effects of the air, traffic, noise, and public health and safety issues related to the Project. While these impacts may be less than significant individually, they may be significant cumulatively.

9. Analysis of cumulative projects must include local development as well as general and anticipated growth within the Project area. The District is concerned that the proposed Project would have compounding effects that extend beyond the defined Project and area. The EIR cumulative impact analysis must consider the Project's growth inducing impacts and associated public health and safety issues that are reasonably anticipated as result of the proposed Project and potential future impacts the Project may have on the District's ability to construct additional school facilities and/or expand existing school sites.

General:

10. The EIR should include a figure (or figures) that shows general locations for all major Project construction and improvements including, but not limited to, all new tracks (e.g., tracks for transfer of marine containers & additional BNSF tracks), fueling areas, a truck in/out gate, etc. Please clarify the Area of Less Frequent Train Movements as shown in Figure 2, Project Site Area. It is uncertain what the Area of Less Frequent Train Movements represents; if that is the area where additional rail tracks are being proposed, please label as such.

11. The significance determination and the analysis must be consistent throughout the Initial Study. There are a number of instances where the Project impacts are called Less Than Significant but it is stated that these impacts will be discussed in the EIR. Where an impact analysis cannot be substantiated in the Initial Study, these impacts should be considered Potentially Significant and further discussed in the EIR. For example in Section VII(b), Hazards and Hazardous Materials, the impact was determined to be less than significant because an Emergency Response Plan and Health and Safety Plans would be developed and these plans are expected to remedy any dangers associated with an upset or accidental release of hazardous materials. However, the Initial Study states that the adequacy of these plans and measures will be addressed in the EIR. If adequacy of these plans could not be substantiated, the impact should be considered Potentially Significant and properly evaluated in the EIR.

12. The EIR must evaluate the impacts of displacing the existing owners/lessees as result of the consequential relocation of Cal Cartage. Notwithstanding the fact that the currently proposed location for the Cal Cartage operation would create greater distance between Cal Cartage and the nearby schools, the displaced industries may move closer to the schools or have other impacts. The EIR must identify all direct and indirect impacts of Project implementation, including cumulative impacts of these displacements.

13. The EIR must include an adequate analysis of Project alternatives including, but not limited to potential alternatives to truck and rail traffic routing as it relates to offsetting any potential impacts to the District's school facilities, students or staff.

Thank you for the opportunity to respond to the NOP and we would like to be included on the mailing list for all future notices and documents pertaining to this Project. The District looks forward to reviewing the EIR when it is released for pubic review. The District would also be happy to meet with the Port and its consultants to discuss the impact of the Project on the District's facilities, students and staff and potential mitigation measures to offset such impacts. The District trusts that the Port and the District can resolve all school facility, student and staff health and safety concerns in a collaborative manner. Please send one complete set of the DEIR to me at the above address when it becomes available. If you have any questions or would like to meet to discuss our concerns, please feel free to contact me at (562) 997-7550.

Sincerely,

Carri Matsumoto
Executive Director
Facilities Development and Planning
LONG BEACH UNIFIED SCHOOL DISTRICT

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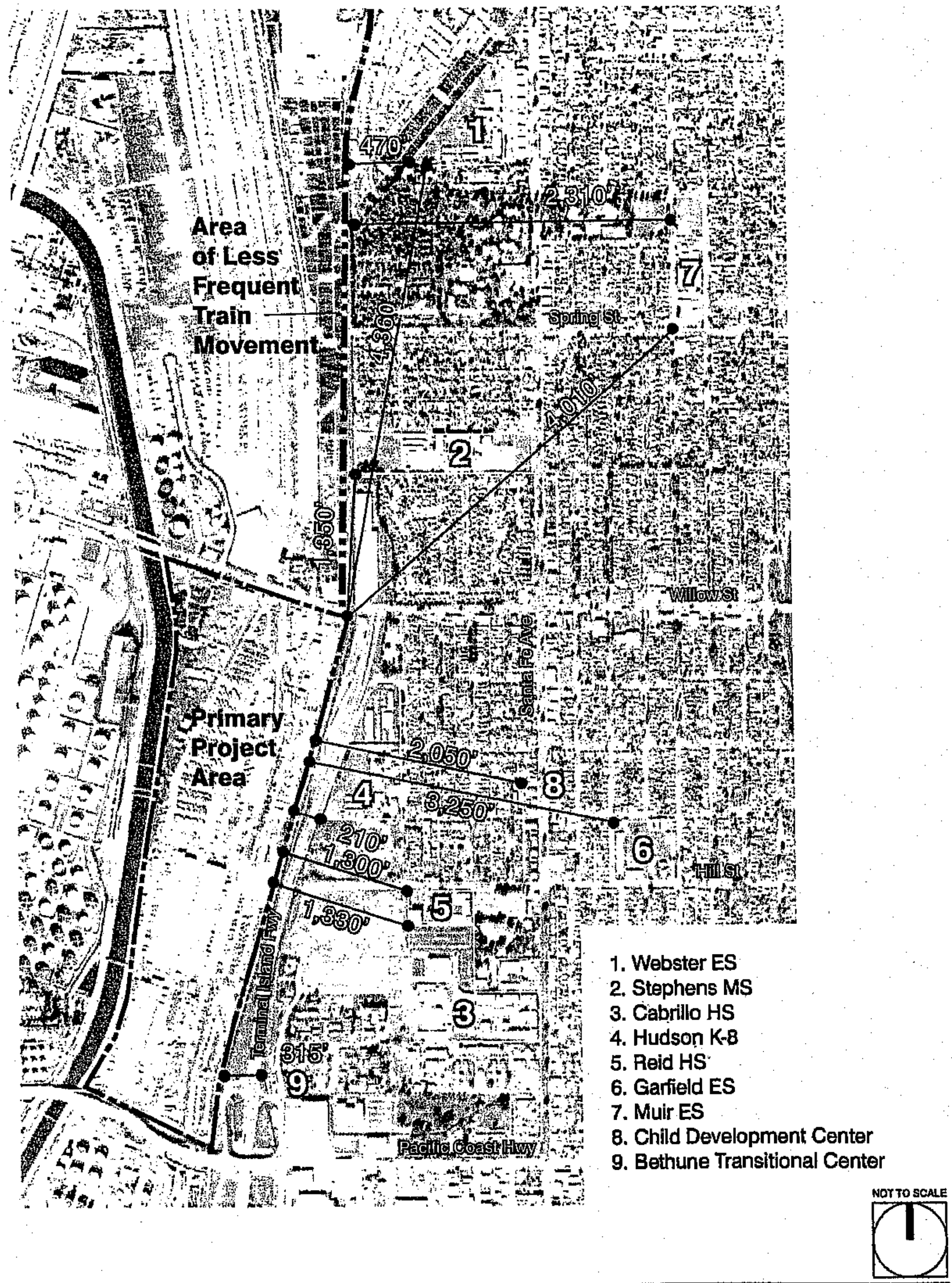
cc: Chris Steinhauser – LBUSD
Kim Stallings – LBUSD

Figure 1


470'
2,310'
Area
of Less
Frequent
Train
Movement
Spring St
4,360'
4,010'
1,350'
Willow St
Santa Fe Ave
Primary
Project
Area
2,050'
3,250'
210'
1,300'
1,330'
Hill St
Terminal Island Fwy
315'
Pacific Coast Hwy
1. Webster ES
2. Stephens MS
3. Cabrillo HS
4. Hudson K-8
5. Reid HS
6. Garfield ES
7. Muir ES
8. Child Development Center
9. Bethune Transitional Center
NOT TO SCALE

Attachments from Comment Letter 110

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projects

Completed Projects

- Alameda Corridor
- Pacific Coast Highway Grade Separation
- Anaheim Pump Station
- Colton Crossing Feasibility Study
- Additional Control Points Project
- CP West Thenard Track Connection Phase 1

Future Projects

- West Thenard Track Connection Phase 2
- SR-47 Expressway
- Cerritos Channel Rail Bridge

Fact Sheet | **Time Line** | **Map** | **Consolidation Activity Report**

Project Description / Overview

The Alameda Corridor is a 20-mile-long rail cargo expressway linking the ports of Long Beach and Los Angeles to the transcontinental rail network near downtown Los Angeles. It is a series of bridges, underpasses, overpasses and street improvements that separate freight trains from street traffic and passenger trains, facilitating a more efficient transportation network. The project's centerpiece is the Mid-Corridor Trench, which carries freight trains in an open trench that is 10 miles long, 33 feet deep and 50 feet wide between State Route 91 in Carson and 25th Street in Los Angeles. Construction began in April 1997. Operations began in April 2002.

Project Need

International trade accounts for one of every 15 jobs in the Southern California region, according to the Los Angeles County Economic Development Corporation. The ports of Long Beach and Los Angeles are the two busiest container ports in the country and, together, the fifth busiest port complex in the world. The ports handled more than $200 billion in cargo in 2001. The rail network serving the ports was not sufficient to accommodate rapidly increasing cargo volumes. The Alameda Corridor consolidated four low-speed branch rail lines, eliminating conflicts at more than 200 at-grade crossings, providing a high-speed freight expressway, and minimizing the impact on communities.

Benefits

- More efficient freight rail movements
- Reduce traffic congestion by eliminating at-grade crossings
- Improvements to Alameda Street
- Multiple community beautification projects
- Cut train emissions
- Slash delays at railroad crossings
- Cut noise pollution from trains
- Reduce emissions from idling automobiles and trucks

Funding

The $2.4 billion Alameda Corridor was funded through a unique blend of public and private sources. Revenues from user fees paid by the railroads will be used to retire debts. Railroads initially paid $15.00 for each loaded 20-foot equivalent unit (TEU) container; $4.00 for each empty container, and $8 for other types of loaded rail cars such as tankers and coal carriers. Over a 30-year period, fees will increase between 1.5 percent and 3 percent per year, depending on inflation. Effective January 1, 2009, fees are $19.31, $4.89 and $9.77 respectively.

Community Programs

Through its contractors and various community partnerships, ACTA administered several programs designed to provide local residents and businesses with direct benefits that will long outlive actual construction.

- Construction industry-specific job training for 1,281 local residents, including 637 placed in union apprenticeships.

30% of all labor hours for Mid-Corridor Trench were performed by local residents living in adjacent zip codes

Through aggressive outreach and technical assistance, ACTA helped disadvantaged (primarily small and woman- or minority-owned) businesses compete for and earn contracts worth more than $285 million, meeting the program goal of 22 percent of all contracts.

On-the-job training and education credits for more than 420 young adults (ages 18-23), who performed community beautification work through the Conservation Corps program.

One-on-one technical consulting for 25 local import-export companies and entry-level, international trade-specific job training for 20 local residents through a joint program with the World Trade Center Association Los Angeles-Long Beach.

Key Features

North-End Project Area

Massive Redondo Junction flyover separates cargo trains, passenger trains, street traffic.

Multiple rail and street bridges add capacity, eliminate traffic conflicts.

Improved rail yard connections enhance cargo flow.

Mid-Corridor Trench

Trench stretches 10 miles long, 33 feet deep, 50 feet wide.

Thirty bridges carry street traffic over the trench, reconnect communities.

Alameda Street improvements ease traffic congestion.

South-End Project Area

Henry Ford Avenue Grade Separation, one mile long, adds rail capacity, eliminates conflicts with street traffic.

Terminal Island Freeway ramp improvements enhance traffic flow.

Multiple higher-capacity rail bridges over water channels speed port access.

Alameda Corridor Transportation Authority
One Civic Plaza • Suite 650 • Carson • California 90745 • Tel (310) 233-7480 • Fax (310) 233-7483

ACTA BOARD APPROVES EXPANDED MISSION AND MAKES KEY RECOMMENDATIONS TO REDUCE TRAFFIC CONGESTION

FOR IMMEDIATE RELEASE:
December 4, 2003

CONTACT:
John Canalis (562) 435-5551
Maria Melendres (310) 847-4307

LOS ANGELES COUNTY, CALIF. – Directors of the public agency that built the Alameda Corridor agreed to an expanded mission Thursday to develop and support projects that more effectively move cargo to points around Southern California, ease truck congestion, improve air quality and make roads safer.

The Governing Board of the Alameda Corridor Transportation Authority (ACTA) unanimously adopted several recommendations that would improve the flow of cargo from the ports of Los Angeles and Long Beach to the rest of the region. While the Alameda Corridor provides an uninterrupted express railway for cargo for transcontinental rail lines, an improved regional intermodal network is needed to deliver local cargo to the Southland's major freight distribution centers.

"ACTA's extensive expertise and experience in identifying and developing innovative projects are resources that should be brought to bear on developing goods movement solutions on a regional scale," said ACTA Board Chairman and Long Beach Vice Mayor Frank Colonna. "We have the institutional know-how, the government structure and stature to play a major role in solving what is the most vexing problem facing our region and our transportation infrastructure today."

ACTA's governing board, which includes representatives from the cities and ports of Los Angeles and Long Beach, as well as the Metropolitan Transportation Authority, directed the agency to:

- Coordinate with the ports, shippers, wholesalers and retailers to work together on expanding the operating hours of the intermodal distribution system
- Develop a proposal to optimize existing on-dock rail capacity
- Evaluate the viability of a regional shuttle train operation
- Support the development of a new near-dock ICTF
- Continue working with Caltrans to plan the State Route Expressway/Commodore Schuyler Heim Bridge project
- Participate in goods-movement studies with the MTA and other agencies.

The recommendations were made to the ACTA Board by its Ad Hoc Committee on Goods Movement. The committee, formed by ACTA in September to evaluate a potential expanded role, is composed of Colonna, Los Angeles City Councilwoman and ACTA Board Vice Chair Janice Hahn, Los Angeles Port Commissioner Thomas Warren and Long Beach Port Commissioner James C. Hankla.

(MORE)

Alameda Corridor Transportation Authority
2-2-2

"We can't wait any longer to reduce truck congestion in the region, and we must look at all of our options," said Hahn, an early proponent of expanding operational hours at the ports.

This method is currently being successfully implemented at other large international port complexes.

ACTA CEO John T. Doherty said, "These proposed projects could significantly improve the region's goods-movement system while reducing truck congestion on local freeways."

Existing surplus capacity of on-dock rail facilities, for example, could be utilized more efficiently to reduce the number of trucks departing port terminals.

In response to the significant growth of new warehouse distribution centers in the Inland Empire, ACTA will evaluate the development of an inter-regional shuttle train system to deliver cargo to these inland distribution centers. A short-haul system would augment Alameda Corridor cargo destined for transcontinental shipment.

In addition, ACTA will support efforts to develop a new near-dock facility where containers can be loaded onto rail that would transport containers via the Alameda Corridor and eliminate those trucks on freeways destined for downtown rail yards. Union Pacific Railroad operates one such facility in the harbor area, and the Burlington Northern Santa Fe Railway is considering a site in the Wilmington area.

ACTA will continue to cooperate with Caltrans on planning efforts to improve State Route 47 (SR47). Preliminary studies indicate that replacing the Commodore Schuyler Heim Bridge and building an elevated connection between the north side of the new bridge and Alameda Street at Pacific Coast Highway would reduce truck traffic on the Long Beach (710) and Harbor (110) freeways, as well as surface streets. The proposed project would improve traffic safety and congestion in the Wilmington area by eliminating five at-grade rail crossings and three traffic signals on SR47.

Opened in April 2002, the Alameda Corridor consolidated train traffic from four branch rail lines into a high-speed freight rail expressway stretching 20 miles between the Ports of Long Beach and Los Angeles and the transcontinental rail yards and railroad mainlines near downtown Los Angeles. It eliminated conflicts at more than 200 street-level railroad crossings, thereby reducing traffic congestion and air pollution.

The project was built on time and on budget by ACTA, a joint powers authority formed by the Cities and Ports of Los Angeles and Long Beach. The seven-member Governing Board is comprised of two representatives from each Port, one from each City, and one from the MTA.

(END)