Memorandum

November 9, 2018

To: Los Angeles Regional Water Quality Control Board

From: Harbor Technical Work Group – SQO Compliance Focus Group Members
Los Angeles Regional Water Quality Control Board: LB Nye, Thanhloan Nguyen
State Water Resources Control Board: Chris Beegan
Port of Los Angeles: Kathryn Curtis, Andrew Jirik, Kat Prickett
Port of Long Beach: Matt Arms, James Vernon

Re: **Total Maximum Daily Load Compliance Approach for Greater Harbor Area Using the Sediment Quality Objectives**

Introduction

Following promulgation of the *Dominguez Channel and Greater Los Angeles and Long Beach Harbor Waters Toxic Pollutants Total Maximum Daily Load* (Harbor Toxics TMDL; Regional Water Quality Control Board [RWQCB] and USEPA [U.S. Environmental Protection Agency] 2011), the SWRCB reinitiated development of the Sediment Quality Objective (SQO) assessment for human health, and the development of guidance documents to support use of SQOs to demonstrate TMDL compliance. SWRCB suggested that the Greater Harbor area be used as a test case to aid in development of the updated SQO policy. To that end, staff from the two Ports, the RWQCB, the SWRCB, and their consultant teams (Southern California Coastal Research Project, Anchor QEA, and Latitude Environmental) formed both an Executive Committee and the Harbor Technical Working Group (HTWG), to oversee and implement special studies to inform both the SQO policy (Sediment Quality Provisions) update and the 2018 TMDL reconsideration.

The SQO Compliance Focus Group was formed from the HTWG to discuss and test various TMDL compliance methods using the Benthic Community SQO and the Human Health SQO. The SQO compliance focus group began meetings in March 2014. Thirteen in-person meetings were held to discuss compliance methods; those meetings occurred on the following dates:

- January 23, March 12, April 17, and October 20, 2014
- January 26, March 3, April 15, August 24, and October 6, 2015
- February 2, March 23, and September 27, 2016
- August 23, 2018

The SQO Compliance Focus Group used the Ports' extensive database and site-specific bioaccumulation model to evaluate various sampling designs, statistical methods, and modeling tools to assist SWRCB in developing recommended methods to evaluate and interpret SQO results. This effort resulted in amendments to the Water Quality Control Plan for Enclosed Bays and Estuaries

– Part 1 Sediment Quality (Sediment Quality Provisions), (Plan; SWRCB 2018). The SWRCB has approved and adopted the Plan under Resolution No. 2018-0028. These amendments are expected to be approved by the California Office of Administrative Law and the U.S. Environmental Protection Agency (USEPA) by 2019 and become effective. The amended Plan includes a general description for using the qualitative sediment condition of Unimpacted or Likely Unimpacted via the interpretation and integration of multiple lines of evidence as defined in the implementation for conducting the aquatic life-benthic community SQO (Benthic Community SQO) and the Human Health SQO to evaluate attainment of beneficial uses.

As noted in the Plan, additional guidance for the use of the SQOs is needed to establish methods to demonstrate TMDL compliance. This memorandum summarizes the SQO Compliance Focus Group's recommended guidance for using the SQOs to determine sediment quality attainment of beneficial uses for the Harbor Toxics TMDL. Separate methods are provided for the Benthic Community SQO and Human Health SQO.

TMDL Compliance Though the Aquatic Life-Benthic Community SQO

The TMDL compliance framework developed by the SQO Compliance Focus Group for the Benthic Community SQOs was designed in the form of a flow chart to provide guidance for the assessment, evaluation, and documentation required to demonstrate compliance with the TMDL. In general, this framework is intended to be adaptive to other sediment quality TMDLs; however, this document reflects the work of the focus group and therefore the examples discussed are specific to the Harbor Toxics TMDL. This document discusses the objectives and approaches for each step illustrated in the flowchart below.

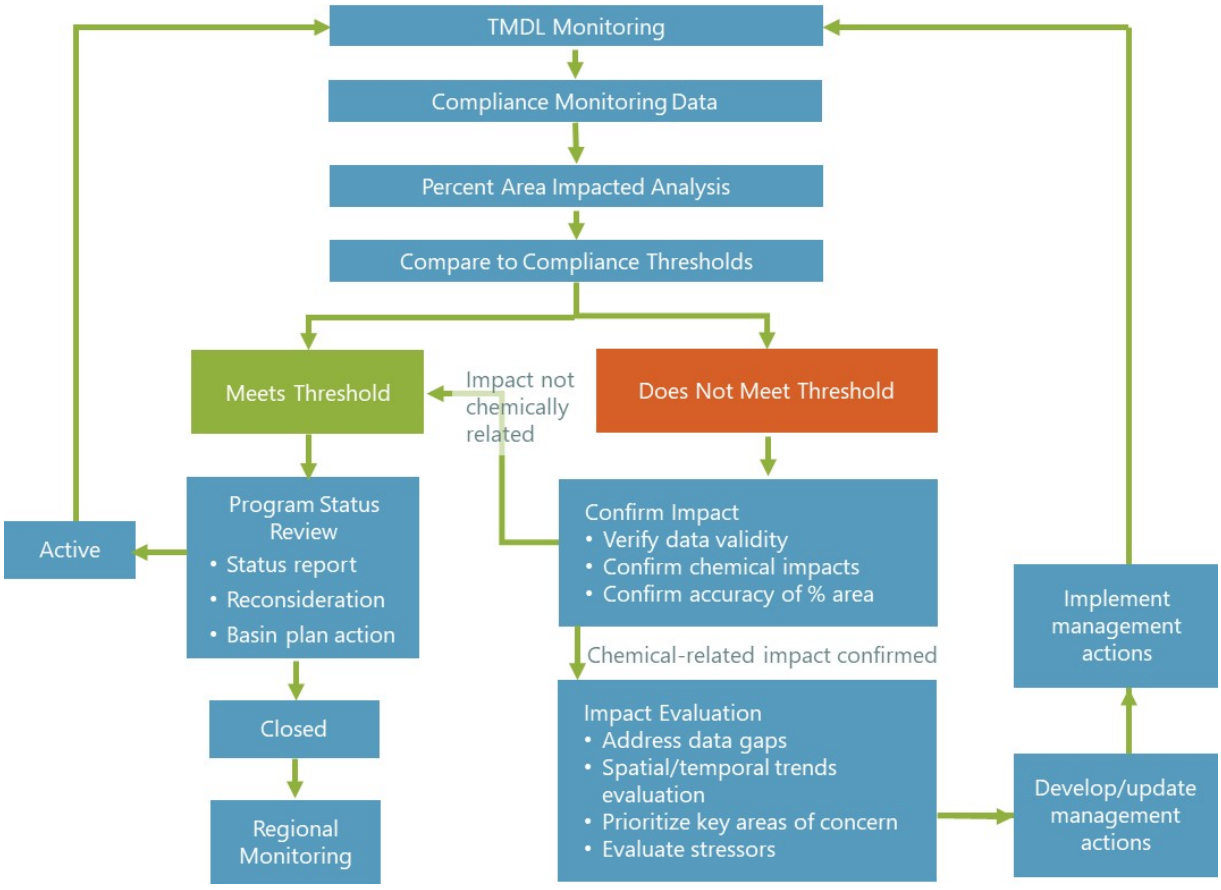

Figure 1. TMDL Compliance Evaluation Through the Benthic Community SQO Flowchart

Conduct Monitoring

The initial compliance assessment should be based on the most recent 6 years of SQO data collected as part of a TMDL compliance monitoring program based on a randomized design.[1]

[1] For the Harbor Toxics TMDL, the TMDL compliance monitoring of sediment was performed in 2013 and 2018 in conjunction with the Bight '13 and Bight '18 programs using the Bight program's stratified random design. In 2016, samples were collected randomly within designated areas identified in the Basin Plan Amendment.

- Sample collection should be based on random design whether or not sampling is conducted in conjunction with the Southern California Bight (Bight) Regional Monitoring Program.
- Sampling Design considerations:
  - Compliance with benthic community objective is determined based on the individual assessment of two or more stations within a site (Appendix A of the amended Plan, SWRCB 2018).
  - Establish assessment units in consultation with the RWQCB.
  - The sample design and objectives (e.g., resampled stations, spatial distribution of samples, and sample methodology) should be reviewed to determine if samples that are combined from multiple years of sampling or multiple sampling events are independent.
  - Use only the most recent data point for resampled locations. Resampled stations are not independent data points within the dataset, and this lack of independence must be considered when calculating the percent area.
  - Consider grouping of smaller TMDL-defined waterbodies into larger assessment units.
  - Consider site-specific conditions such as hydrodynamics, sediment transport, sediment sources and sinks, sediment conditions, and knowledge of operations (e.g., maintenance dredging, ship staging, and movement) within the waterbody when establishing assessment units.

Assessment units for the Greater Harbor waters includes the following:

- Los Angeles/Long Beach (LA/LB) Outer Harbor (includes Inner Cabrillo Beach)
- LA/LB Inner Harbor (includes Cabrillo Marina, Fish Harbor and Consolidated Slip). It is noted that Consolidated Slip and Fish Harbor are identified as hot spots in the Harbor Toxics TMDL and will be assessed and managed separately. Once management actions are implemented, these areas will be assessed within the LA/LB Inner Harbor assessment unit
- Eastern San Pedro Bay (includes Los Angeles River Estuary)

Compare to SQO Categories

The amended Plan includes methods for implementing the SQO to demonstrate attainment of receiving water limits for the protection of benthic community as described in Chapter III.A.2.a (SWRCB 2018). The text specifically defines the condition when an exceedance of a limit occurs, the interpretation here, defines the protective condition. The following guidance is provided:

- A percent area-based assessment is used to determine acceptable pass rate in the amended Plan. Calculation of percent area should be based on data from spatially representative samples selected using a randomized study design or equivalent spatial analysis.

- A TMDL assessment unit passes the threshold if the area is greater than or equal to 85% Likely Unimpacted or Unimpacted and has no Clearly Impacted stations located within the assessment unit.
- Where impacted stations consist entirely of Possibly Impacted, confirmation monitoring may be conducted to further evaluate the spatial extent of the impacts or confirm the impact is present at the existing stations.
- The most recent 6 years of monitoring data from each station will be used for the categorization.

Area-Impacted Analysis Method

The amended Plan specifies states: Calculation of percent area should be based on data from multiple spatially representative samples selected using a randomized study design or equivalent spatial analysis.

Consistent with the amended Plan, both the TMDL required monitoring program and the Bight monitoring use randomized sampling designs. The Bight method for calculating the percent area impacted has been well established (Bight '13 CIA Committee 2013); however, this method is only appropriate for Bight program-collected data within pre-identified Bight-related strata. An alternate sampling design was used for the required TMDL monitoring program. Consequently, a method for calculating the percent area impacted that can be applied to both data sets is needed. The percent area analysis is based on use of a commonly used spatial analysis method called the Theissen polygon approach. In brief, the approach involves dividing the sampled area into numerous polygons, each of which is defined by a single data point. The boundary of the polygon is the midpoint between two data points. A weighted average of the measurements is calculated based on the size of each polygon. This is a non-statistical, widely used and conservative method involving the creation of polygons around each data point; the borders of the polygons are set half way between adjacent data points.

Alternate percent area-impacted approaches may include other sampling designs or data analysis methods that may be more appropriate for TMDL assessment. Careful consideration of sampling design should be applied as early as possible in the TMDL assessment and should consider factors such as: appropriate strata for data analysis, suitability of data for percent area calculations, and comparability of results from previous and future sampling events. Potential alternate sampling designs might include:

- Bight strata modification: Consider post stratifying Bight samples in order to produce analysis strata that match TMDL assessment unit(s)
- GIS-based interpolative methods – May be a preferred method if data are compiled from various program.

Area-Impacted Analysis Using Theissen Polygon Approach

When the Theissen polygon approach is applied as part of an area-impacted analysis, the SQO categorical value of each data point is assigned to the entire polygon and the percent area impacted is calculated using the following equation:

$$\% \text{ Area Impacted} = \frac{\Sigma \text{ Area for each failing stations in assessment unit}}{\Sigma \text{ Area for all of the stations within the assessment unit(km2)}} X\ 100$$

Where: A failing station = Possibly or Likely Impacted

The percent area impacted for each assessment unit will be compared to the threshold set in the amended Plan. Specifically, the Plan defines the threshold for the percent area impacted (i.e., exceedance of a receiving water body to protect aquatic life). The total percent area categorized as Possibly Impacted and/or Likely Impacted equals or exceeds 15 percent of the site area over the duration of a permit cycle. The area also is deemed impacted if there are one or more Clearly Impacted stations in the area being evaluated.

Meets Benthic Community SQO Protective Condition

If the assessment unit meets the threshold (e.g., 85% of the assessment unit is determined to be Unimpacted or Likely Unimpacted), the process will move to a TMDL status review. Under this review, the State or a stakeholder group will develop a TMDL status report and submit it to the RWQCB for review and provide a recommendation for keeping the TMDL active (i.e., additional TMDL monitoring and compliance assessment is needed) or close the TMDL (i.e., the assessment unit meets the Benthic Community SQO).

- Develop status report: Summarize results, analysis methods, and other lines of evidence pertaining to attainment of Benthic Community SQO compliance targets.
- Submit status report to the RWQCB for review, discussion, and decisions on active or closed status.
    - Active: Continue TMDL monitoring per the TMDL management action plans. It may be appropriate to propose a change to the TMDL monitoring (e.g., change in area of concern, specific contaminant is identified, or impairment is driven by non-chemical concern such as pH or low dissolved oxygen, in which case, frequency and the number of sampling locations and total number of analytes may be modified).
    - Closed: TMDL compliance is met through SQOs. Request that the RWQCB develop Basin Plan Amendment to modify Implementation Plan of the TMDL for Benthic Community SQO-related monitoring and reporting. Participate in regional monitoring per State requirements.

Does Not Meet Benthic Community SQO Protective Condition

In the case where the assessment unit does not meet the compliance threshold, then the State and/or stakeholder may wish to further review data used in the assessment. These optional activities might include:

- Verify/validate all data.
  - Recheck quality assurance/quality control (QA/QC) and confirm data are valid. Review all tests related to each line of evidence (e.g., results of the various benthic indices, toxicity tests, and chemicals present) and evaluate if there is anything unusual or unique about the sediment at each station (e.g., extremely sandy or recently dredged). Exclude data determined to be invalid.
  - Determine if station results are confounded and cannot be interpreted (exclude from analysis).
- Confirm chemical impacts (e.g., identify stations that are impaired due to non-chemical stress such as physical disturbances). If station impacts can be confidently associated with non-contaminant (e.g. physical disturbances, eutrophication) stressors, flag these stations and exclude them from the percent area calculations. If contamination impacts are not present, consider reclassifying station (e.g. likely impacted to possibly impacted). Currently, tools and scientific understanding may not be available to support station reclassification. Any decision regarding station exclusion/reclassification must be documented and based on scientific information and approved by the Regional Board.
- Recalculate the percent area impacted if any stations have been excluded or reclassified from the dataset in either of the previous two steps.
- Recalculate the percent area impacted using additional current conditions data to improve the coverage of the waterbody and better understand which locations are impacted.
- The timeframe for data representing "current" conditions will depend on the dynamics of the waterbody and annual sediment loadings.
- Review historical datasets for spatial and temporal trends for the assessment unit.

Impact Evaluation for Waterbodies that Do Not Meet Benthic Community SQO Protective Condition

Once a contaminate-related impact has been confirmed, a management or monitoring plan needs to be developed. Further evaluation or additional monitoring may be required to identify the cause or nature of contaminants and related impacts and support management plan development. Optional investigations and steps that may be required to develop management plans may include:

- Addressing data gaps
- Evaluating spatial and temporal trends and magnitude of impairment
- Prioritizing areas of interest for further study or delineation (as indicated in Policy Section Chapter IV.A.4)
  - Refer to sediment management plans for the waterbody, if they exist.

  - Identify existing programs that are expected to improve sediment quality.
  - Identify management response plans, which may simply include continued monitoring.
- Evaluating stressors
  - Policy Chapter IV.A.4 lists various considerations.

Develop or Update Management Actions

Management actions should be developed to bring contaminated sediment concentrations and/or other contaminant sources to levels that are protective of and will improve benthic community health. Sediment management actions are costly and the potential for recontamination can limit the long-term effectiveness of remedial actions. Therefore, it is critical to confirm ongoing sources are controlled. Management actions should be designed to meet the compliance schedule required in the TMDL Implementation Phases, or more generally for the applicable regulatory compliance process requirements.

For the Harbor Toxics TMDL, water quality control efforts are being implemented locally and regionally to reduce or eliminate ongoing sources to the Greater Harbor area. Source control and sediment management actions are provided in the TMDL Implementation Plan (RWQCB and USEPA 2011) and Contaminated Sediment Management Plans (CSMPs; Anchor QEA, 2016a, 2016b, Los Angeles County 2016), the ports' Water Resources Action Plan (WRAP; Ports 2009), and the broader Watershed Management Plans and Enhanced Watershed Management Plans (City of Long Beach. 2016; City of Los Angeles, 2014). The CSMPs were developed to provide a mechanism for determining and prioritizing sediment management areas and outlining a process to evaluate management alternatives.

Implement Management Action and Monitoring Plans

Implement identified actions under the updated management action and monitoring plans by completing the following:

- Document in the TMDL Implementation Plan required reports.
- Comply with the TMDL Implementation schedule.
- Request Basin Plan Amendment if specific stressors have been identified and a modification of the TMDL/monitoring plan is justified (e.g., change in analytes and/or frequency of sampling).

For each management action, a monitoring plan should be developed to determine/confirm effectiveness in meeting desired goal.

Continue TMDL Monitoring

Assessment unit monitoring will continue as per the Implementation Plan, and TMDL compliance assessment through SQOs will initiate after the next monitoring event.

- Continue monitoring per the Implementation Plan requirements.

TMDL Compliance through the Human Health SQO

The compliance framework developed by the SQO Compliance Focus Group for the human health SQO tiered assessment framework was designed as a flow chart to provide guidance for the assessment, evaluation, and documentation required to demonstrate compliance with the TMDL. In general, this framework is intended to be adaptive to other sediment quality TMDLs; however, this document reflects the work of the group and therefore the examples discussed are specific to the Harbor Toxics TMDL. This document outlines the objectives and approaches for each step illustrated in the flowchart below.

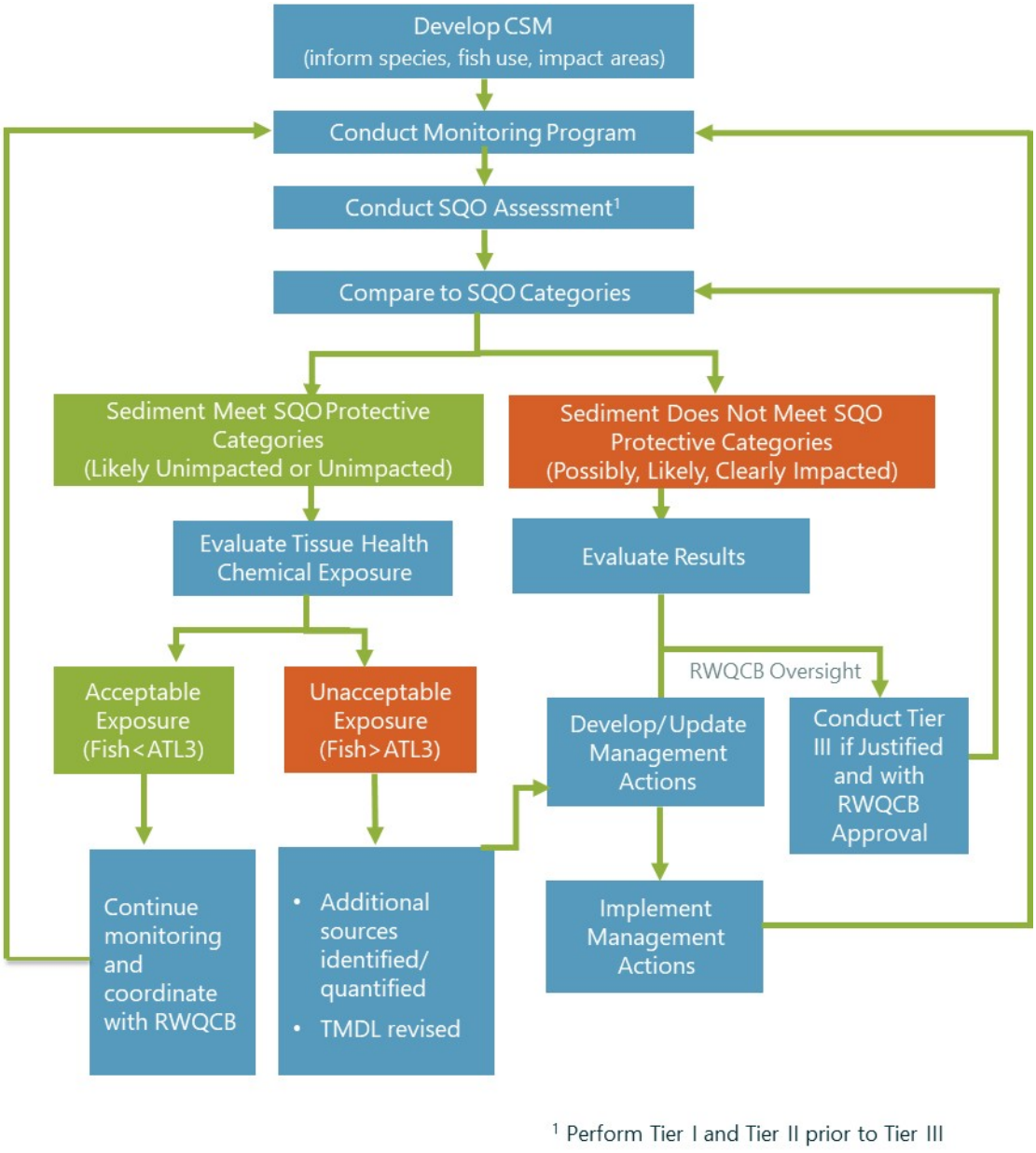

Figure 2. TMDL Compliance Evaluation Through the Human Health SQO Flowchart

Develop Conceptual Site Model

Prior to evaluation, a conceptual site model (CSM) should be developed consistent with methods described in the amended Plan (SWRCB 2018). The selection of species of interest is a key concern during CSM development. Species selection will consider the following:

- Whether the fish are commonly caught and consumed by anglers in the region
- Whether the fish have been shown to have elevated concentrations of the contaminants of concern
- Whether the fish of interest have been shown to be present in sufficient numbers for collection and analysis
- Whether the movement of the fish of interest has been thoroughly investigated and is reasonably understood
- The degree of fish movement and site fidelity for the species is important, because they control direct and indirect exposure of fish to contaminants from the site and other areas.

The assessment unit should be defined for the evaluation of sediment impairment and should consider the following:

- Size/extent of the site should be as relevant as possible to the fish forage area. Site selection should consider where the fish are likely to be exposed and where they might forage (consult home range information). Guidance should note the forage range for each species in the Tier II Decision Support Tool (DST).
- Confirm the size is appropriate to uphold the assumptions in the model, if applied. A conservative approach may be to assume that the fish get all their exposure from a site (for Tier II). From Appendix A-5, a minimum site area of 1 km^2 is required for Tier II assessment, as this area encompasses a sufficiently large portion of the forage range of most of the sportfish species that can be used in the Tier II assessment. Application of the Tier methodology to smaller sites is likely to provide II an inaccurate site linkage evaluation because uptake from foraging activities outside of the site is not specifically considered. Assessment of sites <1 km^2 may require a Tier III assessment that may involve the development and use of an alternative bioaccumulation model for purposes of determining sediment linkage. For small sites of 1-10 km^2 that are being evaluated using a Tier II assessment, California halibut or striped mullet should not be included as target species because their forage range is much larger than the site. Consequently, a Tier III assessment may be needed for sites where California halibut is the most abundant sportfish with a potential link to sediment.
- Size/extent of the site should be inclusive of the area of concern identified by the RWQCB but not necessarily be limited to the area of concern. If the size is too large, the site might not be sensitive for assessment.

- However, for an area that needs to be assessed by itself (e.g., regulatory or jurisdictional boundary limitations), a conservative approach may be applied to assume sediment linkage is wholly due to site sediment conditions.

For the Harbor Toxics TMDL, several factors were used to determine appropriate assessment units.

- Jurisdictional boundaries (e.g., city and stakeholder jurisdictional boundaries)
- TMDL defined waterbodies (e.g., Consolidated Slip, Fish Harbor, Eastern San Pedro Bay)
- Fish movement zones
- Known environmental habitat related factors (e.g., deeper outer harbor open water areas, vs. shallower, more confined inner harbor areas)

Conduct Monitoring

Monitoring may be conducted in association with special studies, stormwater monitoring programs, National Pollutant Discharge Elimination Systems monitoring programs, or regional monitoring programs. See Section III of Appendix A of the amended Plan for a discussion of monitoring design considerations. A monitoring program should be developed to collect data needed to conduct an effective human health SQO evaluation. Specifically, the monitoring program should consider the following data needs:

- Spatially distributed sediment chemical and physical parameters
- Spatially distributed fish tissue chemical parameters
- Fish movement patterns
- Fish habitat
- Evidence of natural recovery
- Background concentrations for contaminants of concern

If the prescribed compliance monitoring program does not include these elements, special data collection efforts may be conducted to fill data gaps.

Conduct SQO Tiered Assessment

The initial compliance assessment should be based on the most recent (within 6 years) data available and assumes that the minimum data requirements can be met (Section IV.A.2.). Data collection methods should be consistent with the procedures identified Appendix A of the amended Plan and technical support materials (Bay et al., 2017). A Tier I screening assessment should be conducted first. If the area is determined to be Impacted, the more detailed Tier II assessment using the DST may be performed.

Compare to SQO Categories

The overall site assessment category is determined using the decision matrix presented in Table 22 of Appendix A (SWQCB 2018). Site sediments categorized as Unimpacted or Likely Unimpacted meet the human health SQO condition protective of human consumers for each contaminant class separately. Site sediments categorized as Possibly Impacted, Likely Impacted, or Clearly Impacted do not meet the SQO protective condition.

Meets Human Health SQO Protective Category

If the assessment unit meets the threshold (e.g., the assessment unit is determined to be Unimpacted or Likely Unimpacted), the process will move to evaluate if fish tissue concentrations meet SQO chemical exposure concentrations for human consumption (Figure 2). Specifically, tissue from the three species identified in the TMDL monitoring program (white croaker, California halibut, and surfperches) are averaged based on the proportion of fish consumed (SWRCB 2018) and compared to the SQO defined acceptable exposure level, ATL3. For cases where both the SQO protective categories for sediment and human health exposure levels in fish have been demonstrated to meet protective condition, the process will move to a TMDL monitoring program to confirm conditions are maintained. Under this review, the ports will continue monitoring and potentially develop a TMDL status report and/or revised monitoring program in coordination with the RWQCB.

For cases where SQO sediment categories are met, but the human health exposure level in tissue is unacceptable (i.e., where the average tissue concentration is greater than the ATL3) source analysis would be conducted to determine all sources contributing to fish tissue body burden. New source information will inform management actions which may include revisions to the TMDL and/or additional named dischargers with new allocations.

Does Not Meet Human Health SQO Protective Category

If the assessment unit does not meet the compliance threshold, then the State and/or stakeholder group may wish to start by further reviewing data and performing an evaluation to confirm the validity and appropriateness of data used in the assessment. Optional review activities might include the following:

- If the assessment determines the site to be Possibly Impacted, Appendix A suggests confirmation monitoring may be conducted to verify that impacts are present.
- Verify/validate all data.
    - Recheck quality assurance/quality control (QA/QC) and confirm data are valid. Exclude data determined to be invalid.
- Review data appropriateness.
    - Confirm data are informative and representative. Review all fish tissue and sediment data and confirm that the Biota Sediment Accumulation Factor (BSAF) makes sense by evaluating the relationship between sediment and fish contaminant levels. Can

outliers be explained by unique habitat features or conditions that influence the representativeness of specific data?

- Confirm the appropriateness of the timeframe for data and ensure the dataset used represents "current" conditions. This effort will depend on the dynamics of the waterbody and annual sediment loadings.
- Review historical datasets for spatial and temporal trends for the assessment unit. Significant downward trends could inform data usage for the human health SQO tiered assessment.

After the review is complete, any decision regarding data exclusion/reclassification must be documented and based on scientific information and approved by the RWQCB. The SQO Tier II assessment should be rerun if any data have been excluded or site assessment unit has changed.

If site conditions are complex, a site-specific or Tier III assessment may be conducted to supplement the Tier II evaluation. For circumstances where there are complex source inputs, unique site conditions, confounding factors, or site-specific consumption patterns that should be considered, flexibility in SQO tiered assessment via a Tier III assessment process will be allowed. A Tier III evaluation may be employed after completion of Tier II and approval from the RWQCB. In order to proceed with a Tier III evaluation, the site must meet specific criteria defined in Section IV.A.2. of Appendix A (SWRCB 2018).

When it has been confirmed that an area does not meet the SQO tiered assessment threshold, management actions should be developed then implemented. Further information may be needed to identify effective management alternatives.

Develop or Update Management Actions

Management actions should be developed to bring contaminated sediment concentrations and/or other contaminant sources to levels that are protective and will improve human health risks from fish consumption. Sediment management actions are costly and the potential for recontamination can limit the long-term effectiveness of remedial actions. Therefore, it is critical to confirm ongoing sources are controlled. Management actions should be designed to meet the compliance schedule required in the TMDL Implementation Phases, or more generally for the applicable regulatory compliance process requirements.

For the Harbor Toxics TMDL, water quality control efforts are being implemented locally and regionally to reduce or eliminate ongoing sources to the Greater Harbor area. Source control and sediment management actions are provided in the TMDL Implementation Plan (RWQCB and USEPA 2011) and Contaminated Sediment Management Plans (CSMPs; Anchor QEA, 2016a, 2016b, Los Angeles County 2016), the ports' Water Resources Action Plan (WRAP; Ports 2009), and the broader

Watershed Management Plans and Enhanced Watershed Management Plans (City of Long Beach. 2016; City of Los Angeles, 2014). The CSMPs were developed to provide a mechanism for determining and prioritizing sediment management areas and outlining a process to evaluate management alternatives.

Implement Management Action and Monitoring Plans

Implement identified actions under the updated management action and monitoring plans by completing the following:

- Document in the TMDL Implementation Plan required reports.
- Comply with the TMDL Implementation schedule.
- Request Basin Plan Amendment if specific stressors have been identified and a modification of the TMDL/monitoring plan is justified (e.g., change in analytes and/or frequency of sampling).

For each management action, a monitoring plan should be developed to determine/confirm effectiveness in meeting desired goal.

Continue TMDL Monitoring

Assessment unit monitoring will continue per the Implementation Plan, and TMDL compliance assessment through SQO tiered assessment framework will be initiated after the next monitoring event. Monitoring will continue per the Implementation Plan requirements.

Conduct Tier III Assessment

If a Tier III evaluation is warranted in accordance with Section IV.A.2.d. of Appendix A (SWRCB 2018), and with permission of the overseeing RWQCB, site-specific approaches would be used to examine sediment linkage and to determine human health consumption risks.

Once a Tier III evaluation process has been developed, that tool/process is used to evaluate sediment linkage and/or human risk for future evaluations. The development of Tier III (supported by RWQCB) is confirmation of the need and support of a site-specific evaluation. Therefore, reevaluating sediment condition with a Tier I or Tier II is no longer appropriate. Ultimately, the evaluation approach adopted as part of the Tier III assessment would be used to develop management alternatives and confirm or evaluate TMDL compliance.

Tier III Assessment Units

Special studies have been conducted in the Greater Harbor area to examine fish usage patterns. The assessment units for the Tier III assessment were defined as fish movement zones (FMZs). These zones were developed with data and information regarding habit quality, including aquatic habitat data, benthic infaunal abundance data, and Harbor bathymetry (Anchor QEA 2014a). Additionally, the movement of two species, white croaker and California halibut—evaluated as part of regional fish tracking studies conducted by CSULB (Lowe et al. 2015a, 2015b)—was also considered.

A detailed description of FMZ development is provided in the Bioaccumulation Model Report (Anchor QEA 2017). The FMZs developed for the Harbor and outside harbor areas to which they are exposed included the following:

- Dominguez Channel Estuary
- Consolidated Slip
- LA Inner Harbor
- Fish Harbor
- Seaplane Lagoon
- LA Outer Harbor
- LB Inner Harbor North
- LB Inner Harbor South
- LB Outer Harbor
- Los Angeles River Estuary
- Eastern San Pedro Bay
- Outside Harbor Exposure Area[2]
- PV Shelf (multiple FMZs)[3]

Ideally management actions to address potential needs for TMDL compliance would match the Tier III assessment unit boundary (i.e., FMZ). This is because the FMZs encompass areas relevant to chemical exposure via fish consumption. Best professional judgement should be used to apply the assessment results for each FMZ to TMDL compliance boundaries as appropriate.

Tier III Evaluation of Sediment Linkage

Understanding the linkage between sediment and fish tissue contaminant concentrations is essential to accurately define acceptable levels of sediment contaminant concentrations and to predict the effectiveness of sediment management actions on fish tissue and associated human health risk levels. Site-specific linkage evaluations may be completed by using site-specific BSAFs, based on site-collected and paired organism and sediment measurements, or by developing site-specific bioaccumulation models that estimate fish tissue concentrations and calculate BSAFs. Numerous

[2] This is the area immediately outside the Harbor gates that represents a portion of the WRAP model grid.
[3] Includes four FMZs that were established on PV Shelf based on the data collected by Wolfe and Lowe (2015), along with consideration of chemical contamination data and bathymetry described in the Bioaccumulation Model Report (Anchor QEA 2017)

modeling frameworks are available for estimating sediment and fish linkage, and selection of an approach (i.e., site-specific BSAF or modeling framework) should be based on several considerations including the following:

- Need for a model that is steady-state or dynamic in time and space
- Ability to incorporate fish habitat usage or fish movement
- Ability to incorporate both site and off-site sources and contaminant fate and transport processes

Several approaches that may be used to determine site-specific linkages between sediment and fish tissue are as follows:

- Modifications to DST. The DST is based on the model used to evaluate sediment linkage and associated risks in San Francisco Bay. Modifications to some model parameters (i.e., diet) in the DST may be possible to account for site-specific differences.
- Site-specific empirically based BSAFs. This approach involves estimating BSAFs based on the linear (or other) relationship between site-collected and paired sediment and fish tissue concentrations. Assumptions are that there is a significant relationship between sediment and fish tissue concentrations, the spatial scale is appropriate, and there is equilibrium between the organism and sediment or water, and between sediment and the overlying water column. This approach may not be applicable to dynamic systems or systems in which there is significant fish movement.
- Other bioenergetic, mechanistic, and dynamic models or other Gobas-based models that have been peer-reviewed and demonstrated to be technically sufficient to address or incorporate site-specific parameters.

If the model is developed to determine sediment linkage, monitoring data will be used to confirm model predictions of the current condition (i.e., sediment, water, and fish tissue quality). If empirical data consistently fail to match model predictions after several monitoring events, model updates may be necessary.

Tier III Evaluation of Consumption Risk

Site-specific data or approaches also may be used to estimate human health consumption risk. The assessment may incorporate information from local fish consumption surveys into multiple-species exposure assessments and/or consumption limits. There may be great variability in fish ingestion rates and species consumed. Market basket analyses or fishing access may vary within assessment units. In addition, specific fish species consumed or available for consumption may not be included in the Tier II DST. Site-specific information may include the following:

- Site-specific consumption rates, either a specific value or a distribution
- Market basket composition
- Expanded list of species for consumption

Tier III Site Assessment: Comparison to SQO Categories

The Tier II thresholds are applied for the Tier III site assessment. Probabilistic model outcomes may be categorized using the Tier II thresholds. Deterministic models may be used to quantify the sediment linkage using the categories and thresholds provided below.

Categories for Tier III Sediment Linkage

See Table 21 in Appendix A (SWRCB 2018) [same as Tier II]. This categorization is applicable to both deterministic and probabilistic models.

Categories for Tier III for Consumption Risk

See Table 19 in Appendix A (SWRCB 2018) (same as Tier II)

References

Anchor QEA, 2014. *Data Gaps Analysis for Bioaccumulation Model Development.* Prepared for Ports of Long Beach and Los Angeles. August 2014.

Anchor QEA, 2016a. *Draft Contaminated Sediment Management Plan: Long Beach Harbor.* Prepared on behalf of the City of Los Angeles. January 2016.

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Anchor QEA, LLC, 2017a. *Bioaccumulation Model Report*. Greater Los Angeles and Long Beach Harbor Waters. In Support of Final Dominguez Channel and Greater Los Angeles and Long Beach Harbor Waters Toxic Pollutants Total Maximum Daily Load. Prepared for Ports of Long Beach and Los Angeles. April 2017.

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