Project Plan

North San Francisco Bay Selenium TMDL

California Regional Water Quality Control Board
San Francisco Bay Region

July 2007

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Project Plan

Selenium TMDL for North San Francisco Bay

Background

The purpose of this document is to describe the scope of work for the development of a selenium Total Maximum Daily Load (TMDL) project to address concerns of impairment of beneficial uses in the northern segments of San Francisco Bay (North Bay). Table 1 shows the proposed key milestones and timeline for the project. This Project Plan is a step in the TMDL project development process subsequent to the Project Definition phase which began with the preparation of the Conceptual Model/Impairment Assessment (CM/IA) report in 2005. It has been developed according to California's TMDL guidance and corresponds to project phases 3 to 7 of the state's TMDL development process.

Table 1: **Timeline and Preliminary Milestones for Developing the North San Francisco Bay Selenium TMDL**

		Completion Date
Stakeholder Outreach & Involvement	Preliminary Project Plan	April 2007
	Detailed Project Plan	July 2007
	Preliminary Project Report	May 2008
	Draft Project Report	October 2008
	CEQA Scoping Meeting	December 2008
	Peer Review Package	January 2009
	Public Review Package	May 2009
	TMDL Adoption Hearings	July-Sep 2009

The Plan is structured around tasks that address major TMDL elements and takes into account associated implementation and regulatory actions. The main outcome of this process will be a project report containing results of technical analyses and the resulting recommendations pertaining to all these elements. The project report will also provide all supporting documentation for a Basin Plan amendment that will establish the TMDL and implementation plan to attain water quality objectives for selenium in North Bay. Finally, this Project Plan will

serve as a starting point for discussion with stakeholders and other interested parties and will guide the development of the detailed Project Plan and further resources needed for the completion of the North Bay selenium TMDL.

Resources

The overall approach, anticipated level of technical detail, and on-going and planned work associated with main elements of this TMDL, together with major milestones and deliverables, are presented below. Tetra Tech Inc. has been engaged by the Western States Petroleum Association to provide scientific support through the TMDL development process. Four major tasks have been identified to complement the Water Board's staff work on this project:

1. Task 1: Data Compilation and Review
2. Task 2: Model Evaluation and Application
3. Task 3: Stakeholder and Public Participation Process
4. Task 4: Project Management

The outline of technical assessments that will be performed by Tetra Tech is also described below while the detailed description of Tasks 1 to 4 and the deliverables are listed in Appendix A. The work requiring technical support is also marked as "External" in the scope of work summary table for each TMDL element.

Water Board staff has allocated 0.8 PY (person years) through September 2009 for project management, coordination and stakeholder participation process. Additional staff allocation of approximately 2.2PY will also be required to develop selenium tissue targets, write a project report and the basin plan amendment, followed by preparation of responses to comments and board agenda packages.

Elements of TMDL Development

Problem Statement

The problem statement will describe the water quality issues that prompted the development of the selenium TMDL for North San Francisco Bay (North Bay) and will document the environmental settings and geographical extent of the TMDL applicability. It will also present a concise summary of the nature of the impairment, selenium related hazards, and the presence of endangered or threatened species and selenium-sensitive species in North Bay.

This project will address selenium impairment in the North Bay area only, which is defined for the purpose of this project as extending from the Sacramento/San Joaquin Delta to the Central Bay. This northern part of the Bay differs significantly from the South Bay as it receives most of the fresh water and sediment inflow discharged into the Bay.

Selenium concentrations in North Bay do not exceed the California Toxic Rule (CTR) saltwater criterion (5 µg/L) for protection of aquatic life. However, the CTR objectives are not designed to protect wildlife from dietary exposure to

selenium and thus do not protect human consumers of Bay waterfowl. The 1987 OEHHA human health advisories against the consumption of diving ducks leading to the 303(d) listing of segments of the Bay in 1998, signified an impairment to the designated beneficial use of commercial and sport fishing (COMM). Moreover, elevated selenium concentrations found in clam and fish tissue could cause impairment of other beneficial uses such as shellfish harvesting (SHELL), estuarine habitat (EST), fish migration (MIGR) and preservation of rare and endangered species (RARE).

Information provided in the CM/IA for San Francisco Bay (2005), additional reports evaluating the ecological effects of a proposed re-opening of the San Luis Drain, and reports associated with the development of new water quality objectives should be sufficient to complete the Problem Statement and revise the impairment assessment. We will also use SWAMP and RMP monitoring data and readily available scientific literature in developing the Problem Statement.

Tetra Tech will conduct an additional review of available data. Table 2 shows potential sources of data organized by location and type of impairment.

Table 2: **Data Compilation and Analysis**

Sources and Locations	**Data Sources**
Point Sources	
Wastewater Plants	Municipalities, WWTP, Regional Board
Refineries	Refineries
Stormwater	Municipalities, Regional Board
Other Point Sources	
Upstream Sources: Sacrament River San Joaquin River	USGS, Regional Board, Literature sources
Nonpoint Sources	
Non-urban land	USGS, Regional Board
Internal Sources	
Bay sediments	USGS, SFEI, RMP, Literature reports
Selenium cycling and speciation in water, wetlands, sediments	USGS, SFEI, RMP, Literature reports
Data on Impairment	
Invertebrates	USGS, SFEI, RMP, Literature reports
Fish	USGS, SFEI, RMP, Literature reports
Bird eggs	USGS, SFEI, RMP, Literature reports

For the purpose of defining the Problem Statement, Tetra Tech will also identify sensitive habitats in the North Bay area where risk to wildlife could be substantially increased because of the current or potential future elevated levels

of selenium. Wildlife species most at risk, including endangered and threatened species and their sensitivity to selenium, will be also evaluated.

Scope of Work: Problem Statement	**Resources**
Collate, review and synthesize information on selenium in North Bay and revise CM/IA if necessary	External
Present trends in data in graphical and tabular format	
Compile all data relevant to North Bay into a database and develop a GIS-based system for examining spatial data	
Identify sensitive species and habitats, determine selenium related risks and describe key foodwebs in those sensitive habitats	
Prepare Problem Statement section for project report	Internal

Numeric Targets

Numeric targets identify specific water column, sediment and/or tissue indicators that express the desired conditions of the water body and ensure attainment of the water quality standards. This project will establish a concentration-based fish tissue target for the protection of aquatic life and birds in North Bay. These targets will be developed in parallel to the standard-setting process that is currently underway and the joint federal-state effort to develop selenium wildlife water quality criteria for California and the San Francisco Bay system.

The target development will start with documenting fish tissue selenium concentrations in species representing various food web levels. We will review available exposure data, including selenium concentrations in prey species and receptor tissue, and examine bioaccumulation factors.

Concurrently, assessment and interpretation of the available water quality standards, health and risk criteria, and their applicability to the conditions in North Bay will be conducted. This evaluation will be based on existing guidelines and recommendations, in particular:

1. Draft Aquatic Life Water Quality Criteria for Selenium – 2004 (US EPA 2004)
2. Guidelines for Interpretation of the Biological Effects of Selected Constituents in Biota, Water and Sediment (Selenium) (US DOI 1998)
3. US FWS ecological risk recommendations based upon selenium residues

This, together with the evaluation of the toxicological effects in fish and waterfowl, will help formulate preliminary targets that are protective of aquatic life and human health.

The first step will include a literature review and a technical report by Tetra Tech summarizing available toxicological information including background levels of selenium, known toxicological data on effects as well as the literature and agencies' recommendations for selecting numeric targets. The review will cover selenium risk threshold ranges documented in the latest scientific studies that may lead to adverse reproductive effects in fish, embryo deformity, or reduced survival in hatchlings.

Scope of Work: Numeric Targets	**Resources**
Conduct literature review of supporting toxicological information	External
Develop fish tissue target using available criteria and guidelines	Internal
Prepare a report documenting target development and Numeric Targets section of the project report	Internal

Source Analysis

This section will identify, characterize, and rank sources of selenium that contribute to the selenium pool in the North Bay. It will also quantify selenium loadings from those sources, the timing of selenium delivery into North Bay as well as internal fluxes of selenium in the Bay.

A preliminary source identification assessment and estimates of selenium loadings have been reviewed and presented in the CM/IA for San Francisco Bay (2005). The three main sources of selenium identified thus far are: the San Joaquin River together with seleniferous agricultural drain water, the Sacramento River, and discharges from petroleum refineries, all of which bring selenium to the northern reach of the Bay system.

Further evaluation of the selenium sources and loadings will focus on updating this information for external and internal sources to the Bay. We will identify and attempt to minimize uncertainties in load estimates by considering additional data sets and better characterizing selenium sources such as sediment, biota, municipal wastewater, and urban runoff.

A key task will be evaluation of seasonal variations in selenium loads from riverine input, and determination of critical flow conditions. Monitoring data indicate that a significant fraction of selenium in the Bay is attached to sediment. When sediment-laden freshwater flows into shallow, brackish waters of San Francisco Bay, particles tend to settle out quickly and accumulate in the sediment. This settling process traps the particles, and it can take a long period of time before the trapped selenium is flushed out of the Bay. Analyzing the magnitude and the dynamics of freshwater inflows into the Bay, and water residence times in the northern segments will help identify critical delivery times and refine the load estimates. A mass-balance model similar to that developed for PCBs as well as work conducted by SFEI (2006) and USGS (2000) to estimate selenium loads entering the Bay from the Sacramento and San Joaquin Delta, will be considered while selecting the most suitable modeling option for examining seasonal variations.

Tetra Tech will undertake exploratory data analyses to establish concentration ranges, explain data variability, and determine trends in concentrations over time and seasons. Calculations of loads and fluxes will be also performed for all external and internal sources of selenium.

Scope of Work: Source Analysis	**Resources**
Data interpretation and analyses to review and update source identification and load assessment in CM/IA so it is applicable to North Bay: Review and analyze selenium concentrations in effluent from industrial and municipal wastewater facilities Re-evaluate and update selenium loading estimates from petroleum refineries Assess presence of selenium in urban runoff and quantify loads Verify proportion of bio-available selenium contributed by each source Evaluate changes in riverine selenium loads (seasonal, wet and dry weather loads) and determine critical flow conditions and residence times	External Internal
Examine the importance of atmospheric sources and compute approximate loads	External
Analyze data on concentration of selenium in the Bay sediments and calculate fluxes	External
Prepare Source Analysis section in the preliminary project report	Internal

Linkage Analysis

A TMDL linkage analysis investigates the relationship between pollutant loadings and applicable water quality standards to determine the capacity of the water body to assimilate the pollutant.

Modeling options will be evaluated to determine their ability to simulate selenium fate and transport in North Bay, calculate the selenium assimilation capacity, and support evaluation of management scenarios. While selecting a modeling approach, we will take into account the capacity of the model to simulate complex linkages between external sources of selenium discharged into North Bay as well as the physical and biological transformations that occur within the Bay.

First, a selenium mass-balance model, conceptually similar to that developed for PCBs, will be tested to determine its ability to describe the fundamental functions of the Bay and to document longer-term relationships between external, mostly agricultural and watershed loads of selenium, conveyed to North Bay through the Sacramento and San Joaquin Rivers. This modeling

exercise will provide the first approximation of the level of reduction required from those sources in order to sustain desirable water quality in the Bay. As a next step, we will consider utilizing a food-web model to translate the proposed fish tissue targets to selenium levels in waters and sediment.

Secondly, an approach proposed by Luoma and Presser (2000) for forecasting ecological effects of selenium will be tested to predict water, particulate, invertebrate, and predator selenium concentrations under different ecological and management scenarios. This model will also allow testing whether the proposed target values can be met and what it would mean for the selenium cycling in North Bay.

Developing the Luoma-Presser approach for North Bay will require a detailed review of the model input requirements and determination of whether there are suitable data available to conduct simulations of selenium movement in the Bay and evaluation of alternative load scenarios. Additional data may be required to verify selenium concentrations in clams and bird tissue and to determine if there are distribution patterns that can be linked to the known anthropogenic sources. These monitoring and evaluation efforts will parallel efforts that are already underway. USGS leads a major joint project (US EPA, US FWS) to develop selenium water quality criteria to protect wildlife in the San Francisco Bay system and intends to employ the Luoma-Presser approach. It is possible that this TMDL project will be able to benefit from the work conducted by USGS and we will collaborate with the agency to receive updates on their work.

TMDL Assimilative Capacity of North San Francisco Bay

An essential part of the linkage analysis is evaluation of assimilative capacity of North Bay for selenium. One way to quantify the assimilative capacity is to determine maximum external loads of selenium to the Bay that will result in attainment of the numeric targets and applicable water quality standards.

The assimilative capacity of North Bay for selenium depends largely on its tendency to accumulate in sediments, and through biotransformation processes enter into the aquatic food web. Therefore, background concentrations in water column and bottom sediments, primary productivity, the rate of transformation from inorganic to organic selenium, flow regime, timing and magnitude of sediment delivery, and sediment type, are all important factors that will be considered during the analysis. The Luoma-Presser model provides an option to simulate delivery, movement, and transformations of selenium and at the same time allows testing of alternative loading scenarios. The model could also help determine the magnitude of selenium load reduction that may be necessary to achieve specific fish tissue targets and/or compliance with water quality objectives.

Scope of Work: Linkage Analysis	**Resources**
Evaluate and revise conceptual model for selenium in North Bay to: Better describe characteristics of North Bay Include discussion on interactions between selenium	External Internal

bioavailability and food webs	
Communicate knowledge of pathways, sources, dominant processes and bioaccumulation	
Recommend a conceptual and modeling framework to link the proposed fish tissue target to external sources and the presence of selenium in the Bay	
Review assimilative capacity calculation methods and determine assimilative capacity of North Bay	External Internal
Evaluate links between riverine loads, residence times in the Bay and salinity, and their impact on selenium transport and impairment	
Interpret sediment fluxes and contributions from identified sources in the context of potential biological effects	
Select, modify, and apply selenium fate and transport model	External Internal
Develop scenarios for testing and calibration of the model	
Evaluate model uncertainties and assumptions, and discuss model prediction capacity	
Develop models and run simulations to translate effects of projected loads on concentrations in the receiving waters, sediment and fish and bird tissue and attainment of the target	
Use model simulations to develop and test a framework for allocation strategy	External
Technical Project Report: complete technical analysis and modeling	External
Prepare Linkage Analysis section in the project report	Internal

Wasteload and Load Allocations

The first step in developing an allocation strategy for selenium will be to classify all natural and anthropogenic loads from external and internal sources according to their magnitude and relative ecological significance. The Source and Linkages Analysis sections together with the estimated assimilative capacity for North Bay will provide a basis for conservative determination of the extent of selenium load reductions necessary to meet the proposed water quality targets.

Environmental factors as well as economic and technological feasibility will be taken into account while selecting the most suitable and cost effective load allocation strategy. Several alternative approaches to apportion loading amounts are discussed in the US EPA and TMDL guidance documents (US EPA 1991, CSWQCB 2005). Allocation strategies developed for the San Francisco Bay previous TMDLs and PCB TMDL will also be consulted for the most workable ideas.

Margin of safety

To ensure an implicit margin of safety, conservative assumptions will be employed throughout all steps of the TMDL development, from developing conceptual understanding and establishing the fish tissue target to data analysis and interpretation. However, the complex biochemistry of selenium and the resulting uncertainties in estimates of selenium loads may call for an added explicit margin of safety as well.

Scope of Work: Allocations	**Resources**
Identify and evaluate allocation options	Internal
Calculate and document wasteload and load allocations	Internal
Evaluate margin of safety and effects of seasonality	Internal

TMDL Implementation Plan

Our implementation plan will identify prevention measures, control strategies, and restoration actions necessary to attain the allocations and the target. It will also set timeframes and designate parties responsible for carrying out the proposed plan. In addition the plan will identify short and long-term milestones and a monitoring strategy necessary to measure effectiveness of the TMDL implementation. To address wasteload allocations implementation through the NPDES permitting process, we will work with local agencies and stakeholders to identify specific actions necessary to carry out load reductions identified in the TMDL.

Our implementation plan will take into consideration current and potential future sources of selenium. It will include measures to: a) control all external source of selenium in North Bay, b) manage internal sources and the Bay system (e.g. dredging), and c) identify and resolve main uncertainties and key assumptions. Monitoring and surveillance to confirm progress of attainment of the target and allocations will be also discussed.

The selenium TMDL for the Lower San Joaquin River has already established selenium load limit reductions required to meet the water quality objective of 5 µg/L (4-day average). However, further collaboration with the Central Valley Water Board will be required to address selenium impairment in North Bay and, in particular, to deal with the uncertainties associated with the expected flow increases coming from the San Joaquin River into the Bay.

Specific areas of uncertainty in the analyses supporting development of the selenium TMDL will be addressed as part of TMDL implementation, and studies to resolve these uncertainties will be considered.

Scope of Work: Implementation Plan	**Resources**
Develop a list of implementation options and evaluate their efficiency and resources required	Internal External
Monitoring plan to evaluate TMDL effectiveness and implementation	Internal
Adaptive implementation and uncertainties	Internal

Basin Planning Process Plan

Establishment of regulatory provisions of the TMDL, along with the appropriate implementation measures, follows the regulatory approval process that requires making an amendment to the Basin Plan. The necessary steps include formal actions listed below together with an evaluation of economic and environmental considerations.

1. Preparation of draft Basin Plan Amendment
2. Scientific Peer Review
3. Regulatory Analyses (CEQA, Environmental Checklist)
4. Water Board Meeting: Informational hearing
5. Water Board Meeting: Adoption hearing

Scope of Work: Basin Planning	**Resources**
Convene CEQA scoping meeting	Internal
Prepare Basin Plan Amendment	
Prepare Peer Review package	
Assess environmental impacts and reasonable foreseeable implementation actions	
Complete CEQA Environmental Checklist	
Prepare Public Notice package	
Prepare Board Meeting Testimony Hearing documents	
Prepare Adoption Hearing package and process	

Stakeholder Participation/ Involvement Plan

Stakeholder involvement and public participation are vital components to success of the TMDL and subsequent implementation of project recommendations. As required by the Basin Planning process, we will provide several opportunities for stakeholder input and communication to the public on

the progress of TMDL development. In addition to a CEQA scoping meeting, formal review, comment period and public hearings, we will:

- Actively seek public participation and input from the stakeholders through direct communication at public workshops and by sending informational materials
- Develop and maintain interested-parties lists for public outreach
- Convene an Advisory Committee to aid in evaluation of data, model selection, implementation options and to provide regular feedback on development of the TMDL
- Establish a Technical Review Committee to ensure that the scientific basis of the project and ,therefore, key decisions and assumptions, are technically sound

The Center for Collaborative Policy (CCP), a program of California State University at Sacramento, will facilitate and support the stakeholder process. The Center's public outreach coordinator will lead this effort, developing appropriate outreach tools and leveraging stakeholder and regulating agency networks and traditional media options to maximize public awareness and enhance participation in the project. A detailed description of this process, project logistics, responsibilities and deliverables are presented in Appendix A (see Task 3). A separate stakeholder implementation plan prepared in accordance with Water Board staff guidelines may also be developed.

At a minimum, we will solicit stakeholders' input and provide opportunities to contribute to the project development at the following workshops:

1. Workshop 1 – Presentation of the Project Plan to develop selenium TMDL in North Bay
2. Workshop 2 – Presentation of the technical background for the project and preliminary findings (Preliminary Project Report)
3. Workshop 3 – Review of modeling results and their implications for developing allocation strategy and implementation plan
4. Workshop 4 – CEQA scoping meeting and project overview

In addition to presenting outcomes of technical analyses these Workshops will provide a forum for assessing best management practices and developing a robust implementation plan that will guide selenium reductions in North Bay.

Scope of Work: Stakeholder Participation	**Resources**
Convene stakeholder workshops and maintain interested parties involved in the TMDL development	External Internal
Professional facilitation and technical support	External

Table 3 summarizes the steps required to develop the selenium TMDL for North Bay and shows completion dates.

Table 3: **Summary of TMDL deliverables and completion dates**

	Project Component	Deliverables	Completion Date
Phases 3 and 4	**TMDL Elements**		
	Problem Statement	Section, Staff Report	August 2007
	Public Participation: Workshop 1	*Plan to Develop TMDL*	*October 2007*
	Numeric Targets	Section Staff Report	March 2008
	Source Analysis	Preliminary Project Report and Revised CM/IA	May 2008
	Public Participation: Workshop 2	*Technical Background and Preliminary Findings*	*April 2008*
	Linkage Analysis	Complete Technical Analyses and Modeling	July 2008
	Allocations	Section, Staff Report	August 2008
	Public Participation: Workshop 3	*Preliminary Allocations and Implementation Strategy*	*August 2008*
Phase 4	**Implementation Plan**		
		Implementation Options Report	October 2008
		Monitoring Plan	November 2008
Phases 5 and 6	**Regulatory Action Selection and Process**		
		CEQA scoping meeting	December 2008
	Public Participation: Workshop 4	*CEQA Scoping meeting and Implementation Plan*	*December 2008*
		Basin Plan Amendment	January 2009
		Peer Review Package	January 2009
		Implementation and CEQA Analyses	March 2009
		Public Review Package	May 2009
Phase 7	**Water Board Approval Process**		
		Informational Hearing	July 2009
		Adoption Hearing	September 2009

References

Abu-Saba, K. and S. Ogle. 2005. *Selenium in San Francisco Bay: Conceptual Model/ Impairment Assessment*. Final Report to the Clean Estuary Partnership, June 2005.

CSWQCB. 2005. *A process for Addressing Impaired Waters in California.* State of California S.B.469 TMDL Guidance. June 2005.

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US DOI. 1998. Guidelines for Interpretation of the Biological Effects of Selected Constituents: Selenium. pp 139-184. Accessed: January 2007 at http://www.usbr.gov/niwqp/guidelines/index.htm)

US EPA. 1991. Technical Support Document for Water Based Toxics Control. EPA-505-29-001. Office of Water. Washington D.C.

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APPENDIX A

Statement of Work and Project Description for Technical Support

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STATEMENT OF WORK AND PROJECT DESCRIPTION FOR TECHNICAL SUPPORT SELENIUM TMDL AND THE FISH TISSUE TARGET FOR NORTH SAN FRANCISCO BAY

June 22, 2007

Prepared for: **Western States Petroleum Association**
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The California Regional Water Quality Control Board, San Francisco Bay Region (Water Board) is in the process of finalizing a Project Plan to Develop the Selenium TMDL and Fish Tissue Target for North San Francisco Bay. The Water Board's plan anticipates technical support from outside sources to augment Water Board staff efforts to ensure completion of the TMDL by early 2010. Tetra Tech has met with Water Board staff to discuss the tasks that would best complement the Water Board's efforts and most effectively facilitate the TMDL process. There exists an opportunity to provide expert scientific support for the development of the North Bay Selenium TMDL and to build stakeholder support so that a science-based process is completed efficiently and on schedule.

Four primary tasks have been identified to complement the Water Board's efforts:

Task 1. Data Compilation and Review

Task 2. Model Evaluation and Application

Task 3. Stakeholder and Public Participation Process

Task 4. Project Management

These four tasks are described separately below.

Task 1: Data Compilation and Review

As a first step in the preparation of a TMDL for selenium in the North San Francisco Bay, Tetra Tech will perform a compilation of the most up-to-date data from a variety of public sources, including data collected by the Regional Monitoring Program, by the US Geological Survey, and data collected by dischargers into the Bay. The types of data collected will include selenium water chemistry as well as ancillary parameters, such as suspended solids, flow rates, etc. In addition, available data on selenium in sediments and in biota (invertebrates, fish, and bird eggs) will be compiled. New information on selenium in biota and human-health effects will also be reviewed. New information on selenium concentrations in the Bay may be available from sediment cores recently collected by the San Francisco Estuary Institute at 20 locations in the Bay. If feasible, these cores will be analyzed for selenium at selected depths to evaluate historical conditions. The data summary will identify data gaps that can be addressed through future sampling and analysis.

The available data will be reviewed, checked for consistency, unit conversions, and calculations to convert to wet and dry weight. Following the review, calculations of loads and fluxes will be performed. The data will be summarized in a consistent, spatially-linked format, and presented as a database and as maps. Exploratory analyses, such as trends in concentration over time or season, and correlations between selenium and other parameters will also be performed. This information will serve as the basis for revisions to the conceptual model (described in Task 2), simulation model development and model calibration.

The general locations from which data will be gathered, as well as the potential sources of data, are identified in Table 2.

Table 2.
Data Compilation and Analysis in Support of Se TMDL

Sources (Se concentrations, flows, related parameters and estimated loads)	**Data sources**
Task 1 a. Point Sources	
Wastewater plants	Municipalities, WWTP, Regional Board
Refineries	Refineries
Stormwater	Municipalities, Regional Board
Other point sources	Regional Board
Upstream sources	
Sacramento River and tributaries	USGS, Regional Board, literature reports
San Joaquin River and tributaries	USGS, Regional Board, literature reports
Task 1b. Nonpoint sources	
Non-urban land	USGS, Regional Board
Air deposition	USGS, Regional Board, literature reports
Task 1c. Internal sources	
Bay Sediments	USGS, SFEI, RMP, literature reports
Selenium cycling and speciation data in water, wetlands, sediments	USGS, SFEI, RMP, literature reports
Task 1d. Data on Impairment	
Invertebrates	USGS, SFEI, literature reports
Fish	USGS, SFEI, literature reports
Bird eggs	USGS, SFEI, literature reports
Bioaccumulation	USGS, SFEI, literature reports

Tetra Tech will perform a review of recent EPA data on sensitive species occurrence and habitat in North San Francisco Bay (NSFB). Tetra Tech will review readily available information to identify sensitive species and NSFB sensitive habitats, to determine selenium related risks, and to describe key foodwebs in those sensitive habitats. The results of this review will be presented in Technical Memorandum 1.

Finally, Tetra Tech will perform a review of available literature data on bioaccumulation and toxicity of selenium to biota, including fish, invertebrates, birds, and mammals. These data will form the basis for selection of the numeric targets for selenium in NSFB.

Deliverables

1. **Project Database:** A database of water, sediment, and biota selenium concentration data collected in NSFB will be developed, so that all project participants have access to a consistent set of data. To the extent feasible from the original datasets, the above data will be georeferenced for inclusion as a GIS layer in maps.

2. **Technical Memorandum 1 - Habitat Maps**: Available data on sensitive species occurrence and habitat in North San Francisco Bay will be compiled and reviewed to produce maps of sensitive species occurrence and habitats in NSFB. A short description of the data and the rationale used to produce the maps will be prepared. The information developed on sensitive species and habitats, potential selenium related risks, and key foodwebs in those sensitive habitats will be summarized.

3. **Technical Memorandum 2 - Source Characterization**: Loads of selenium in NSFB from various sources, including internal sediment sources, as derived from the data evaluation will be summarized in a technical memo that will form the basis of the Source Analysis section for the TMDL. The importance of atmospheric sources and loads will be included in the characterization. The analysis of internal sediment sources will include the calculation of fluxes from sediment. The source characterization will update the source identification and load assessment in the Conceptual Model/Impairment Assessment Report. The results from the analysis of the sediment cores will be presented in Technical Memorandum 2. The technical memorandum will present trends in selenium data in graphical and tabular format.

4. **Technical Memorandum 3 - Toxicological Assessment**. A memo will be prepared summarizing the toxicological information on selenium for input to the numeric target section in the TMDL.

Task 2: Model Evaluation and Application

Task 2.1 Evaluate and select a conceptual model for selenium in San Francisco Bay.

Over the past several decades, there have been a number of activities completed by researchers and regulators that address issues associated with selenium in San Francisco Bay and the surrounding watershed. The earlier work was done in an effort to understand selenium dynamics in the Bay as little was known before then, while in the past several

years research has been driven at least partly in anticipation of conducting a selenium TMDL for North San Francisco Bay. As part of past research, both conceptual models for selenium and mathematical models for contaminant fate in the Bay have been developed. However, to date, no consensus has been reached on what is the most appropriate approach to accomplish the TMDL within the timeline set forward by the Regional Water Quality Control Board (proposed TMDL adoption hearings would be in early 2010, and much of the technical work would be completed within two years).

A first step to resolve these issues is to critically review and critique the existing conceptual models for selenium in San Francisco Bay, and to decide on an appropriate conceptual model for the selenium TMDL application. As early as the 1980s selenium dynamics in San Francisco Bay were being studied by Greg Cutter of Old Dominion University, and others as well (e.g., Cutter and Bruland, 1984). Cutter and his students have continued to be involved up to the present in advancing the knowledge of selenium dynamics in the Bay (e.g., Meseck (2002), Cutter & Cutter (2004), and Doblin et al., 2005). Recently, two major conceptual models of selenium in the San Francisco Bay and the surrounding watershed have been completed. They are:

- Selenium in San Francisco Bay: Conceptual Model and Impairment Assessment (Abu-Saba and Ogle, 2005), and
- Forecasting Selenium Discharges to the San Francisco Bay-Delta Estuary: Ecological Effects of a Proposed San Luis Drain Extension. Professional Paper 1646 (Presser and Luoma, 2006). This work is an update to the earlier work by the same authors (Luoma and Presser, 2000)

The purpose of providing this background is to document that selenium in the Bay has been studied for 20 years, and selenium dynamics within the Bay remain a topic of active research. Therefore, the question to be answered during this task is to select, from existing candidate models, what conceptual model components are to be used that are appropriate for the TMDL study. As part of this task, the researchers who have developed conceptual models will be requested to participate in this process by suggesting an appropriate conceptual model for use in TMDL development. All researchers will be provided with a list of issues that would need to be addressed. A series of meetings with regulators and other stakeholders is anticipated to resolve differences, and to finalize a conceptual model.

Task 2.2 Evaluate, select, and modify selenium fate and transport model

Once selenium conceptual modeling issues are resolved, then attention will shift to evaluating fate and transport models appropriate to San Francisco Bay. It is anticipated that the selected fate and transport model would be modified to incorporate into it a mathematical version of the conceptual model. Such a model would then be used to answer the appropriate TMDL-related questions regarding selenium in the Bay. It will be important to pose and answer such questions up front in order that no implicit assumptions are made about what the model can or can not do. Examples of such questions include:

- What are the data requirements of the model, and how do they relate to the available information?
- Can the model simulate all selenium source and sink types (internal or external) thought to be important? For the point sources (such as petroleum refineries), is the simulated model resolution adequate in the vicinity of the discharge?

- Are the uncertainties manageable? How can they be reduced if needed?
- Can the model simulate the effects of dry and wet seasons, which affect residence times and resuspension/deposition of sediments?
- Can the model simulate biogeochemical transformations adequately?
- Does the model provide the information needed for bioavailability and bioaccumulation predictions or can these features be added to the model?

At present, there appear to be three candidate models that could be used for this project. If stakeholders believe other models are appropriate, an opportunity for them to suggest models will be made, and those models would be evaluated, as well. At present the following three models are being considered:

- Single box model developed by Davis (2004) that has been used for mercury and PCB fate and transport in the Bay.
- Multibox model of PCB transport (Oram et al. 2006)
- EFDC, a public domain three-dimensional hydrodynamics model supported by EPA (http://www.epa.gov/ATHENS/wwqtsc/html/efdc.html)

Once the candidate models have been identified, a comparison of their capabilities, limitations, prior applications, and other relevant features will be made. This will help to form a basis for model selection. Also to be evaluated is how the conceptual model will be represented within the chosen fate and transport model, or if the conceptual model can just accept input from the hydrodynamics model without being linked to it.

Below, some initial discussion is provided regarding each of the three models. The single box model represents the bay as a single well mixed source. It might be possible to apply the model to only the North Bay, if it can be shown that the model results are insensitive to the exchange with the South Bay. A potentially large limitation of a single-box model is that any point sources to the bay are artificially diluted, and mixed instantaneously throughout the Bay. Thus it would be difficult to discern the response to specific load allocations. On the other hand, such a simplified model could be used to discern long term trends in the water column and sediments.

The multibox model (MBM) has been developed by SFEI. This model divides the Bay up into 50 segments, with each segment containing two layers (thus the entire Bay is simulated). This model builds on an earlier hydrodynamics model developed by the USGS. It has been applied to PCBs in the Bay, and is still undergoing testing. The most recent results of using the model for PCB transport were presented at the May 2007 CEP meeting.

The third model choice is the Environmental Fluid Dynamics Code (EFDC). It simulates the Bay in three-dimensions, and includes hydrodynamics, sediment transport, and water quality capabilities. It has been applied to numerous estuaries in the United States. The USEPA has chosen to support EFDC, and it is publicly available over the internet.

Currently, the three categories of models identified here are broadly focused on chemistry in water and sediments, and not directly on bioaccumulation. An enhancement that is proposed for these models is the inclusion of modules to represent uptake of selenium by biota at different trophic levels, and to produce as model outputs, selenium concentrations in target organisms such as invertebrates, fish and aquatic waterfowl. In most instances, these modules are data driven and based on regressions between target

biota concentrations and concentrations in water, sediment, and other concentrations in lower trophic levels. This task will involve the development of a selenium bioaccumulation model for NSFB based on regional data to the extent possible, with supplementary information from the general scientific literature on selenium bioaccumulation.

It is apparent that the three levels of modeling would each require different levels of resources to modify and apply to this proposed project. Both the multibox model and EFDC are complex enough that they should be calibrated and validated to hydrodynamics, sediment transport and exchange, and selenium concentrations, both in the water column and in the sediments, as the available data allow. Successful model calibration and validation may be needed to convince stakeholders of the veracity of the model.

Task 2.3 Apply selenium fate and transport model

Once a model has been chosen, modified, and calibrated/validated then model applications would begin. A set of scenarios assembled by the technical team, regulators, and other stakeholders will be simulated. The responses and uncertainties to those responses will be evaluated. It will be important to include a margin of safety in the simulations, as well. As results are generated, they will be disseminated routinely for comment and revision. Once these results are accepted by all parties, they will be used as a basis for TMDL allocations.

Deliverables

1. **Technical Memorandum 4 - Revised Conceptual Model**. Using the data developed in Task 1, a technical memorandum will be prepared that highlights the key selenium transformation and biological uptake processes occurring in NSFB. The memo will be an update to the existing conceptual models of selenium in NSFB and will emphasize the current level of understanding/quantification of these processes. The technical memorandum will present the results of the evaluation of alternative models and select the conceptual model most appropriate to the North Bay.

2. **Technical Memorandum 5 - Model Selection**. Candidate models will be identified and evaluated based on the criteria identified in Task 2b. The capabilities and data requirements of the candidate models will be explicitly identified. The recommended model or models will be identified and the rationale for selection will be specified.

3. **Technical Memorandum 6** - **Simulation Model Results.** The selected model(s) will be applied to generate the results needed to generate the TMDL. The model results will include water column and sediment concentrations, as well as biota concentrations using a site specific model of bioaccumulation as described above. A key consideration will be the evaluation of options for actions that can be taken to meet established numeric targets for selenium in different environmental compartments. The modeling will provide estimates of outcomes for different load reduction scenarios. This information will provide the basis for an evaluation of extent of load reduction that will be required to meet the desired targets in the implementation plan.

4. **Technical Memorandum 7 - Implementation Plan**. Multiple load reduction actions may be implemented as part of the North Bay Se TMDL. This technical memorandum will utilize the modeling results to evaluate the benefits of different implementation options. This analysis will also select, describe and evaluate best management practices and control measures to reduce selenium loads from all internal and external sources. Economic considerations and technical feasibility as well as management actions already underway to reduce selenium loads in the Central Valley will also be addressed.

Task 3. Stakeholder and Public Participation Process

The successful Se TMDL process will require a significant level of stakeholder involvement. Four stakeholder workshops are proposed at key stages of the TMDL-development process. The objectives of each proposed workshop are described below in terms of the projected outcomes.

Proposed Workshops

1. **Workshop 1**. Presentation of Project Plan to Develop Selenium TMDL in North Bay. Each element of the TMDL process will be presented and discussed. Special emphasis will be placed on implementation issues. The objective is to obtain input and comments on the Water Board's Project Plan, including the proposed technical approach and schedule.

2. **Workshop 2**. Presentation of Technical Background for the Project and Preliminary Findings (Preliminary Project Plan). The results of the data compilation and analysis task will provide the basis for decisions on the technical approach for the required TMDL elements: numeric targets, source analysis, linkage analysis and allocations. A revised conceptual model will be presented. Also, the strategy for modeling that will be conducted to demonstrate how allocations will result in standards attainment will also be presented. The objective is to obtain stakeholder input and comment on the data collection task and modeling approach. It will also be important to get stakeholder input and comments on the modeling approach and the implementation options that will be evaluated.

3. **Workshop 3**. Review of Modeling Results, Preliminary Allocations. The modeling results provide the technical basis for the establishment of TMDL allocations and the implementation strategy. The objective is to obtain input concerning the data interpretation and the preliminary allocations, and the implementation strategy.

4. **Workshop 4.** CEQA Scoping Meeting. The objective is to present an overview of the Water Quality Attainment Strategy, involve stakeholders, determine their concerns, and solicit comments.

The Center for Collaborative Policy (CCP), a program of California State University, Sacramento (CSUS), will provide a collaborative public participation process during development of the North Bay Selenium Total Maximum Daily Load (TMDL). CCP will conduct the following tasks.

Task 3.1 Meet with Tetra Tech, WSPA, and Water Board to Develop a Detailed Understanding of Project

CCP management and appropriate project staff will attend up to two startup meetings with Tetra Tech and/or the Water Board. CCP staff will conduct additional research and document review germane to the project.

Task 3.1 Deliverables

- *Email updates on meeting logistics*
- *Meeting summaries*
- *Background educational materials about stakeholder processes*
- *Task related correspondence*
- *Meeting presentation materials (if appropriate)*

Task 3.2 Develop a Complete List of Potential Stakeholders

Using background information from the previous "San Francisco Bay Selenium TMDL Roundtable" (Roundtable) effort and other sources, CCP will assess current regional and local stakeholders' efforts and will identify an appropriate cross-section of stakeholders to be assessment participants (Task 3.3). Activities under this task may include but may not be limited to web-based data searches; library visits; meetings and telephone discussions with agencies, non-governmental organizations, and private citizens; document reproduction, document review and analysis, and similar efforts. Final development of the participant list will benefit from review by Tetra Tech, WSPA, and or the Water Board and ultimate responsibility for identification of stakeholders resides with the Water Board; however, based on CCP's organizational responsibilities to maintain impartiality and independence throughout an assessment process, CCP may or may not revise potential participant lists based on comments from the reviewers.

Task 3.2 Deliverables

- *Background stakeholder information (when appropriate and not confidential)*
- *Task related correspondence*

Task 3.3 Conduct Stakeholder Assessment

The purpose of the assessment is to determine key social, informational, procedural conditions related to the proposed TMDL and to identify appropriate methods to engage stakeholders in this effort. More specifically, the assessment may:

- Clarify and explain stakeholders' desired outcomes from a stakeholder process;
- Identify stakeholders' perceptions about their role in a regional stakeholder process;
- Identify perceived organizational problems, challenges, and potential solutions for any current of future project sponsors;
- Identify from a stakeholder perspective what (if any) data collection/analysis methods are appropriate for the Project;
- Identify what (if any) resources stakeholders can provide to a process;
- Identify the appropriate leadership and organizational structure for a stakeholder process;

- Determine the appropriate decision-making and organizational structure of a stakeholder process;
- Clarify expectations about the design and implementation of associated public participation efforts to publicize a stakeholder process and engage the general public (at appropriate times);
- Clarify expectations about the public and quasi-public use of technical information; and
- Clarify needs and expectations regarding third-party neutral assistance to a stakeholder process.

CCP will conduct up to 20 confidential stakeholder interviews. Interviews will be in person or via phone and are expected to take place throughout the Bay Area. Most interviews are expected to be held individually between a specific participant and 1-2 CCP interviewers. However, when appropriate, CCP will also conduct interviews with discrete groups of similar stakeholders (presuming said participants agree that all results of the interview are confidential). To initiate this subtask, CCP will prepare and distribute assessment invitation materials (including an introductory / invitation letter from the Water Board and potentially WSPA, followed by an introductory letter from CCP describing the assessment process).

Subtask 3.3.1 – Develop Assessment Questionnaire and Background Materials: CCP will prepare an assessment interview questionnaire and introductory invitation materials referred to above. The questionnaire will be structured to accommodate individual and group interviews that may be conducted in-person or by telephone. CCP anticipates the questionnaire will inquire from participants (but will not be limited to), their input on the following topics:

- Past, current, and future Bay Area water quality conditions, particularly regarding Selenium
- Stakeholders to be involved in a multi-party process,
- Historic and current, interpersonal and organizational relationships among stakeholders,
- Goals, objectives, and general visions of stakeholders regarding the TMDL,
- Future organizational methods for the process,
- Current and future technical data uses, needs, and availability,
- Stakeholder histories with collaborative processes,
- Public outreach and involvement techniques,
- Overall timing and costs associated with Project planning and implementation,
- Impacts of, and compliance with Federal, State, and local policies, laws, and regulations,
- Potential barriers to a successful outcome,
- Dispute resolution.

CCP will provide draft and final questionnaires to Tetra Tech, the Water Board, and/or WSPA for review and comment. However, based on CCP's organizational responsibilities to maintain impartiality and independence throughout an assessment process, CCP may or may not revise any iterations of the questionnaire based on comments from the reviewers.

Subtask 3.3.1 Deliverables

- *Draft and final assessment questionnaires*
- *Assessment introduction / invitation letters*
- *CCP introductory letter*
- *Background educational materials about collaborative processes*
- *Task related correspondence*

Subtask 3.3.2 - Conduct Assessment: CCP will conduct the interview based assessment. CCP will conduct all interview logistics including contacting participants; organizing and conducting interviews; and documenting interview results. All interviews will be confidential and interview results will be proprietary to CCP.

Subtask 3.3.2 Deliverables

- *Subtask-related correspondence (potentially confidential to CCP)*

Subtask 3.3.3 – Prepare Assessment Report: Upon completion of interviews and background information review, CCP will prepare a draft assessment report. This report will include at a minimum the following sections: executive summary, project background, description of the assessment process, findings and analysis from the assessment, and recommendations for the project/process. Recommendations in the report may include but may not be limited to the following categories:

- Recommended participants
- Locations of meetings
- Frequency of meetings
- Duration of meetings
- Technical support needs
- Facilitation needs
- Administrative support needs
- Organizational structure and decision-making processes

The draft assessment report will be provided to Tetra Tech (and others as appropriate) for review and discussion. However, based on CCP's organizational responsibilities to maintain impartiality and independence throughout an assessment process, CCP may or may not revise any iterations of the questionnaire based on comments from the reviewers. CCP, Tetra Tech, WSPA and the Water Board will meet to discuss the draft assessment report. Following that meeting, CCP will prepare the final assessment report that will include final recommendations for a stakeholder process.

Task 3.3.3 Deliverables

- *Draft and final assessment report*
- *Meeting summaries*
- *Task related correspondence*

Task 3.4 Implement the North Bay TMDL Stakeholder Process

Assuming that the results from Task 3.3 are favorable to initiate a stakeholder process, CCP will work with Tetra Tech and others to convene the public portion of the TMDL. It is infeasible to recommend the specific format of how stakeholders will be convened until after the assessment and assessment report are completed. A more specific workplan will be prepared by CCP after the assessment however for current scope purposes, CCP presumes that an initial proposal previously provided to the Water Board and WSPA from Tetra Tech will be the basic framework for stakeholder involvement. This framework proposes conducting four workshops at respective key stages of the TMDL development process. These potential workshops include:

1. **Workshop 1** – Presentation of Project Plan to develop the Selenium TMDL
2. **Workshop 2** – Presentation of Technical Background for the project and Preliminary Findings
3. **Workshop 3** – Review Modeling Results and Preliminary Allocations
4. **Workshop 4** – California Environmental Quality Act Scoping Meeting

The workshops will act as key milestones that all project activities will aim for. Each workshop will likely have significant pre, and post work related to the specific delivery of the workshop, the public outreach for and at the workshop, and the "behind-the-scenes" stakeholders activities regarding management of conflicts and opportunities. The following paragraphs provide more detail about the likely labor efforts related to these activities.

Regarding the delivery of each public workshop and overall public involvement, CCP's public outreach coordinator (POC) will lead this effort, developing appropriate outreach tools and leveraging stakeholder and regulating agency networks, and traditional media options to maximize public awareness and participation in workshops (and any related events). The POC will also have the direct responsibility to lead, or work with other leads from the Board, Tetra Tech, and/or WSPA to manage workshop logistics include dates and times, locations, amenities, etc. . More specifically, while premature to determine the exact steps and tools to be used for the Project, CCP assumes that the POC may do but is not limited to the following items:

- Develop a PP strategy (PP). Memorialize PP roles and responsibilities, stakeholder types, outreach tools, event venues, key milestones, etc.
- Coordinate Public Outreach Activities. Ensure that regular communication is taking place with key stakeholders to augment outreach opportunities, etc.
- Coordinate and Manage Media Strategy Issues**.** CCP can support work by others to refine the timeline for news and feature story roll-out, and placement of stories about the Project in appropriate media outlets. CCP can also work with the primary outreach parties to prepare press briefings, organize stakeholder interviews, etc.
- Develop and Coordinate Production of Public Outreach Materials. CCP can help produce, distribute and update a variety of public outreach tools to keep stakeholders and the general public informed of and engaged in the Project.

The CCP assistant facilitator will be responsible for the summarization of each meeting and subsequent preparation of summary reports. Similar summaries will be prepared (on an as needed basis) for related workshop planning meetings

Regarding focused stakeholder involvement, CCP expects that a group will be created to act as a guiding stakeholder group for this effort. The presumption is that the group will act as an

advisory group of stakeholder spokespersons and that their role may be to assess technical information and conclusions, advise the Water Board on key concerns and potential conclusions, and to identify mutually acceptable opportunities that if appropriate and warranted by the project conditions could provide mutual benefits to the Water Board, affected stakeholders, and affected regulated parties. CCP also presumes that the process will include a technical review committee (TRC). The TRC would be a small group, likely made up of a cross section of knowledgeable, qualified specialists that will work to assess and ensure mutual understanding and concurrence on technical problem statements, data objectives, conclusions, etc. CCP's project leader and managing senior mediator will have direct involvement with stakeholders on these efforts.

For the development of this group and advisory committee, CCP will work with the stakeholders to develop mutually agreed operating rules. Similarly, a principal aspect of CCP's work under this task will be a range of "off-line" efforts between the facilitator/mediator and specific stakeholders. An inherent role of the facilitator/mediator is to provide neutral opportunities for stakeholders to discuss their concerns, options, negotiation strategies, etc. In most cases, such discussions will be confidential in order to maintain equity among all stakeholders, and the authentic neutrality of the facilitator. Therefore, the results of such meetings will likely be confidential until and unless, a stakeholder allows the public or quasi-public use of their information. The general purpose of this work will be to conduct pre-assessments of key challenges, pre-stage opportunities for solutions, confidentially assess stakeholders risks associated with the format and content of public workshops, and similar conditions. CCP's project leader and managing senior mediator will have direct involvement with stakeholders on these efforts.

Task 3.4 Deliverables

- *Draft and final revised work plan*
- *Meeting summaries*
- *Workshop logistics (i.e. advertisements, outreach materials, appointments, etc)*
- *Workshop summaries*
- *Draft and Final Operating Rules*
- *Draft and final advisory committee and TRC lists and communications*
- *Task related correspondence*
- *Meeting summaries (potentially confidential to CCP)*
- *Task related correspondence*

Task 4. Project Management

The primary project management tasks will involve coordination with WSPA and the Water Board, coordination with subcontractors, project financial and technical reporting. The budget is based on the following assumptions: weekly conference calls with WSPA, the preparation of monthly technical progress reports, monthly meetings with WSPA, weekly coordination with task leaders, and ad hoc meetings with the Water Board and WSPA. Tetra Tech believes that the success of the TMDL effort will require the project manager's active participation in the technical tasks. The project management tasks are expected to account for 12% of the project manager's time over the expected 18 month period of performance. The combined technical and project management tasks are estimated to utilize between 17 and 20 percent of the project manager's time, depending on the modeling approach selected.

A Technical Review Committee will be established to ensure that key decisions and assumptions that go into the development of the North Bay Selenium TMDL are

technically sound. This task also has the goal of providing an efficient process in which highly specialized expert consultation occurs at specific points in the development of the TMDL, thereby maintaining the trust and support of a wide range of stakeholders. The role of the Technical Review Committee will be to provide credible technical advice. The subtasks involved in the TRC process include identification of TRC members, development of the framework for the technical review process, development of review guidelines, and the preparation of the summary of TRC findings.

Deliverables

1. **Technical Memorandum 8 – Technical Review Committee.** The development of the TRC process will include the design of the framework for the technical review process, preparation of review guidelines, the identification of candidate reviewers, response to requests for additional information during the review process, and the preparation of a summary of the TRC findings.

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