HARBOR TOXICS TMDL MONITORING AND REPORTING PLAN (MRP)

Prepared for:

Tesoro Refining & Marketing Company LLC
Los Angeles Refinery – Wilmington Operations
2101 E. Pacific Coast Highway
Wilmington, CA 90744

Prepared by:

WGR Southwest, Inc.
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Date:

September 11, 2018

LOS ANGELES REFINERY - WILMINGTON OPERATIONS

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MRP REVISION HISTORY

Revision No.	Date	Revised By	Reason for Revision	Sections Revised
1.0	5/29/18	Ana Horn, QISP WGR Southwest, Inc.	Initial **DRAFT** preparation to address Harbor Toxics TMDL Monitoring Plan provisions as required by Order No. R4-2017-0095	All
2.0	8/14/18	Ana Horn, QISP WGR Southwest, Inc.	Revised **DRAFT** plan in accordance with Regional Board comments	4.1, 4.2, 4.3, 6.0, Figure 1, Figure 3
		.		

LOS ANGELES REFINERY - WILMINGTON OPERATIONS

MRP DISTRIBUTION

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1.0 Introduction

This document constitutes the proposed Harbor Toxics Total Maximum Daily Load (TMDL) Water Column, Sediment and Fish Tissue Monitoring and Reporting Plan (MRP) for the Los Angeles Refinery, Wilmington Operations (herein facility). The facility is located at 2101 E. Pacific Coast Highway, Wilmington, CA. The MRP was developed to comply with the Harbor Toxics TMDL Monitoring Program as required in the National Pollutant Discharge Elimination System (NPDES) Permit No. CA0003778, amended by Order No. R4-2017-0095.

The principal objectives of this MRP are to:

- Assess the chemical, physical and biological impacts of discharges from the facility to the receiving water: the Dominguez Channel Estuary,
- Characterize pollutant loads in facility discharges,
- Identify and evaluate pollutant sources, and
- Measure and improve the effectiveness of pollutant controls.

This MRP follows the *"TMDL Element – Monitoring Plan"* provisions in Attachment A to Resolution No. R11-008. Applicable water quality objectives for the TMDL are narrative objectives for Chemical Constituents, Bioaccumulation, Pesticides, and Toxicity in the Basin Plan and the numeric water quality criteria promulgated in 40 CFR Section 131.38 (the California Toxics Rule (CTR)). In addition, sediment condition objectives were determined using the State Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1 Sediment Quality (SQO-Part 1) and the sediment quality guidelines.

The facility's proposed compliance TMDL monitoring program is required to be submitted to the Regional Water Board Executive Officer for public comment and approval. All monitoring as specified in this MRP shall be triggered by the first discharge from the facility to the permitted NPDES outfall. *If no discharge occurs, implementation of this monitoring and reporting plan is not required* (See Section 4.0).

2.0 Facility Information

The facility processes approximately 100,000 barrels per day of crude oil, primarily from California production sources. Crude oil is delivered to the facility via pipeline and marine vessels. The crude oil is converted into a full range of petroleum products, including various grades of automotive and aviation gasoline, jet fuels, diesel fuels, bunker fuels, and petroleum coke. Recovered byproducts include liquefied petroleum gas (LPG), coke and sulfur. Finished products such as gasoline and distillate fuels, and by-products such as residual fuel oil and petroleum coke are exported from the facility via pipeline, marine vessels, trucks, and rail cars; other materials, such as LPG, are exported using rail cars and trucks. The facility has a maximum crude and product storage capacity of approximately 5.6 million barrels. Processes at the facility include desalting, atmospheric distillation, vacuum distillation, fluid catalytic cracking, hydrocracking, delayed coking, hydrotreating, alkylation, catalytic reforming, hydrogen generation, isomerization, and sulfur recovery.

The facility receives commingled storm water and wastewater from the Sulfur Recovery Plant, a facility owned by the Wilmington Refinery, located about 1.3 miles north of the facility. Commingled storm water and wastewater from the Sulfur Recovery Plant is received via pipeline, where it is routed to the facility's treatment system and subsequently discharged to the Los Angeles County Sanitation Districts under Industrial Wastewater Discharge Permit No. 20098.

2.1 Facility Treatment and Controls

Wastewater (commingled storm water and process water) generated at the facility is collected and /or treated by three separate systems:

1. <u>High Chemical Oxygen Demand (HCOD) Treatment System</u>

   Wastewater from the processing unit systems and crude clearing waters are treated in the HCOD treatment system. The HCOD system consist of a pretreatment unit, corrugated plate interceptors, induced gas floatation units, sour water strippers, a dissolved air floatation unit and flow equalization tanks. Effluent from the HCOD treatment system is combined with effluent from the low chemical oxygen demand system and discharged to the Los Angeles County Sanitation District, under Industrial Wastewater Discharge Permit No. 20098.

2. <u>Low Chemical Oxygen Demand (LCOD) Treatment System</u>

   The LCOD treatment system receives wastewater originating from boiler blowdown, cooling tower blowdown, miscellaneous wastewater (including miscellaneous cleanup wastewater, petroleum coke-belt wash waters, excess coke drums cutting and quench waters, hydrostatic test waters, fire system test wastewater and water softener regeneration wastewaters), sulfur recovery plant wastewater, drainage from the truck loading area, and storm water from the facility.

   Drainage areas south of the Pacific Coast Highway is routed to lamella separator number 3 and drainage areas north of the Pacific Coast Highway are routed to lamella separator number 6. Both lamella separator number 3 and number 6 drain to storage Tank Number 15001. Wastewater in Tank Number 15001 is treated by two induced gas floatation units and then routed to the LCOD system Effluent Tank Number 15002. The LCOD system effluent is subsequently transferred to the Tank 25013, where it is combined with the treated effluent from the HCOD system and transferred to Tank 80043. Effluent in Tank 80043 is subsequently discharged to the sanitary sewer.

   During emergency situations, effluent from the lamella separators may be discharged to the Dominguez Channel Estuary through Discharge Point 003. Effluent discharge through Discharge Point 003 is manually controlled by a valve that is normally closed and chain locked to prevent unauthorized discharges.

3. <u>Segregated Storm Water System</u>

   Storm water collected in the tank farms from the north and west sections of the facility consist of non-commingled storm water that remains segregated from other sources of refinery wastewater and storm water. Non-commingled storm water from the north tank farm can be routed by gravity to a collection sump, which discharges to Tank No. 80009. Storm water from the northwest and west tank farms are routed to oil/water separators #7 and #8. Storm water in these separators is subsequently discharged to Pond No. 2, where it is routed to the LCOD system or Tank 80009.

Storm water collected in Tank 80009 is normally routed to the LCOD system and subsequently discharged to the sanitary sewer. During emergency conditions effluent collected in Tank 80009 can be discharged into the Dominguez Channel Estuary through Discharge Point 001.

2.2 Facility Discharge

The facility has a combined storm water storage capacity of 31 million gallons. Under normal conditions, treated wastewater (commingled process water and storm water) and non-commingled storm water is preferentially routed to the LACSD sewer connection.

Under NPDES No. CA0003778, storm water can be released into the Dominguez Channel Estuary through the permitted Discharge Point 001 and/or Discharge Point 003 if flooding of the facility is imminent after taking all reasonable operational steps to contain excess wastewater (i.e. - reaching all on-site storage capacity and the capacity to discharge to the LACSD) and if there are risks to human life, the safety of employees and the community from flooding of the facility.

If a discharge to the Dominguez Channel Estuary occurs, effluent samples are required to be collected during active discharge at the corresponding discharge location (i.e. – Discharge Point 001 and/or Discharge Point 003) for the parameters listed in the permit order. During years of discharge, the receiving water is required to be monitored at monitoring location RSW-001 and bed sediment is required to be monitored at monitoring location SED-001 for the parameters specified in the permit order. In addition, the first discharge through the permitted NPDES outfalls would also trigger the implementation of the Harbor Toxics TMDL Monitoring Program as specified in this MRP.

3.0 MRP Implementation Team

The following table lists the facility’s MRP implementation team members along with their area(s) of responsibility. The implementation team is responsible for ensuring required monitoring and sampling are being performed as detailed in the MRP, as well as ensuring applicable deadlines are being met. The table below is subject to change due to personnel and responsibility.

Table 3.0: MRP Implementation Team

Name	Title	Responsibility
Dave Foster	Vice President	Certification of associated monitoring reports submitted to the LARWQCB.
Robert Nguyen	Environmental Manager	Overall Storm Water Program implementation at the Facility. Approval of facility effluent discharges. Responsible for BMP implementation, employee training and spill response.
On - Duty Facility Operators	Facility Operators	Controls the release of storm water, coordinates storm water related maintenance issues.
WGR Southwest Inc.	Environmental Consultant	Preparation of reports and plans, conducts annual evaluation and provides technical assistance to the facility personnel for storm water compliance issues
Qualified Sampling Contractor	Sampling Supervisor / Technicians	Collects samples as required by the facility’s MRP, completes required field documentation, prepares samples for submittal to laboratory
Eurofins Laboratory	Contracted Laboratories	Analyzes samples and provide detailed laboratory reports of results, and QA/QC data

3.1 Site Maps

Table 3.1 lists the figures incorporated as attachments depicting the facility's location, permitted storm water outfall and drainage, and the monitoring stations to be sampled under this MRP.

Table 3.1- Site Maps

Map Description	Map Name	Figure No.
At least one quarter mile vicinity around the facility, shows nearby bodies of water	TOPOGRAPHIC VICINITY MAP	Figure 1
Facility flow schematic of wastewater and storm water streams	WILMINGTON REFINERY FLOW DIAGRAM	Figure 2
Sampling stations established in accordance with Attachment A to Resolution No. R11 – 008	MONITORING STATIONS	Figure 3 & Figure 4

4.0 Monitoring and Reporting Plan

Under NPDES Permit No. CA0003778, the Wilmington Refinery is required to conduct Harbor Toxics TMDL water column, sediment and fish tissue monitoring in the Dominguez Channel Estuary. Monitoring, as specified in this MRP, is only to be implemented when a discharge occurs to the permitted NPDES outfalls. *If no discharge occurs, implementation of this monitoring and reporting plan is not required.* The facility's permitted NPDES outfalls are designated to be used for emergency purposes only. Storm water and wastewater is preferentially routed to the facility's POTW sewer connection.

If a single discharge occurs to the permitted NPDES outfalls, the first storm water discharge shall trigger the beginning of the monitoring year for the Harbor Toxics TMDL program. All monitoring as outlined in this MRP shall be implemented from the facility's first discharge after the effective date of the permit order. The monitoring year shall begin the day the first discharge from the facility is released and shall conclude one year thereafter.

The Quality Assurance Project Plan (QAPP) supporting this MRP specifies the sample collection protocols, standard analytical procedures, quality assurance / quality control protocols for water, sediment and fish tissue monitoring. The QAPP includes Surface Water Ambient Monitoring Program (SWAMP) methods and procedures to be incorporated in the Harbor Toxics TMDL Monitoring Program. Table 4.1 describes the stations to be monitored under this MRP, along with the sample media and applicable analytical parameters. Compliance with waste load and load allocations shall be addressed as part of the Annual Report submitted to the Los Angeles Regional Water Quality Control Board (LARWQCB).

The LARWQCB Executive Officer may reduce, increase or modify monitoring and reporting requirements, as necessary, based on the results of the TMDL monitoring program. Several of the constituents of concern have numeric targets that are lower than the readily available detection limits. As analytical methods and detection limits continue to improve and become more environmentally relevant, associated responsible parties may be requested by the Executive Officer to incorporate new method detection limits in the MRP and QAPP. Water column, sediment and fish tissue monitoring requirements are described in Section 4.1, Section 4.2, and Section 4.3.

4.1 MRP Implementation Schedule

This MRP is required to be submitted to the LARWQCB within 12 months of the effective date of the permit order for public comment and the Regional Water Board approval. The facility shall initiate monitoring 6 months after the MRP and QAPP are approved by the LARWQCB Executive Officer, unless otherwise directed by the Executive Officer.

Implementation of this MRP, is as follows:

- If *no discharge occurs,* the MRP shall not be implemented.
- If *a single discharge occurs,* all monitoring as outlined under this MRP shall be implemented from the facility’s first discharge after the effective date of the permit order. Receiving water column sampling (including water samples and total suspended (TSS) samples) shall begin during or as soon as possible following the first effluent discharge event. Sediment and fish tissue monitoring must begin within the year of the first effluent discharge event.

Once implementations of the MRP is triggered, sufficient water samples shall be collected to analyze for the required constituents. As specified in Attachment A to Resolution No. R11-008, water column and total suspended solids (TSS) samples shall be collected at the outlet of the storm drains discharging to the Dominguez Channel Estuary; sediment samples and fish tissue samples shall be collected within the Dominguez Channel Estuary. Table 4.1 below provides a summary of the established monitoring stations.

Table 4.1 – Monitoring Stations

Water Body Name	Station ID	Station	Station Location	Sample Media and Parameters[1]
Dominguez Channel Estuary	01	Discharge Point 001 Station	33 ° 47’33.45” N 118 13’48.88” W	**Water Column / TSS:** Lead, Zinc, Copper, PCBs, DDT, benzo[a]anthracene, benzo[a]pyrene, chrysene, phenanthrene, and pyrene, temperature, dissolved oxygen, pH, electrical conductivity and receiving water flow
	03	Discharge Point 003 Station	33 ° 47’08.39” N 118 14’05.95” W	**Water Column / TSS:** Lead, Zinc, Copper, PCBs, DDT, benzo[a]anthracene, benzo[a]pyrene, chrysene, phenanthrene, and pyrene, temperature, dissolved oxygen, pH, electrical conductivity and receiving water flow **Sediment:** Sediment Chemistry[2], Toxicity, Benthic Community Effect
	04	Fish Tissue Sampling Station[3]	33 ° 46’40.94” N 118 ° 14’24.01” W	**Fish Tissue:** Chlordane, Dieldrin Toxaphene, DDT and PCBs

1 – Sampling shall be designed to collect sufficient volumes of suspended solids to allow for analysis of the listed pollutants in the bulk sediment.

2 – Sediment bed samples shall only be collected at Station 03. Sediment chemistry samples shall be analyzed for the full chemical suite as included in Attachment A of the SQO-Part 1.

3 – Fish tissue sampling location is subject to change depending on sampling conditions. If no fish are available within the Estuary during a sampling event, the sampling location may be moved downstream to a location in close proximity to the Estuary (i.e. – northeast end of consolidated slip)

4.2 Water Column Monitoring

Water column monitoring shall be performed at Station 01 and Station 03 for the parameters listed in Table 4.1. Water samples and TSS samples shall be collected during two wet weather events and one dry weather event each year. TSS samples shall be collected at several depths (i.e. – surface, mid-water column, and bottom).

The first large storm event of the season, once MRP implementation has been triggered, shall be included as one of the wet weather monitoring events. Receiving water column sampling (including water samples and total suspended solids (TSS) samples) shall begin during or as soon as possible following the first effluent discharge event. During water column sampling, sufficient volumes of suspended solids shall be collected to allow for analysis of the pollutants in the bulk sediment. TSS samples collected at different depths shall be consolidated and analyzed as one sample for each station. Water and TSS samples shall be analyzed for lead, zinc, copper, DDT, PCBs, benzo[a]anthracene, benzo[a]pyrene, chrysene, phenanthrene and pyrene at Station 01 and 03. General water chemistry including temperature, dissolved oxygen, pH, electrical conductivity and receiving water flow shall be monitored at Station 01 and 03 during each sampling event using the appropriate field instrumentation for measurement. All samples are to be submitted to a state certified laboratory for analysis with an accompanying chain of custody as specified in the supporting QAPP.

Table 4.2 summarizes the waste load allocations (WLAs) as included in the Harbor Toxics TMDL for the Dominguez Channel Estuary.

Table 4.2 – Dominguez Channel Estuary Water Column Concentrations Based WLAs

Lead (ug/L)	Zinc (ug/L)	Copper (ug/L)	PAHs[1] (ug/L)	Chlordane (ug/L)	Dieldrin (ug/L)	4’4 - DDT (ug/L)	Total PCBs (ug/L)
8.52	85.6	3.73	0.049	0.00059	0.00014	0.00059	0.00017

1 – CTR human health criteria were not established for total PAHs. Therefore, the CTR criterion for individual PAHs of 0.049 ug/L is applied individually to benzo(a)anthracene, benzo(a)pyrene, and chrysene. The CTR criterion for Pyrene of 11,000 ug/L is assigned as an individual WLA to Pyrene. Other PAH compounds in the CTR shall be screened as part of the TMDL monitoring.

4.3 Sediment Monitoring

Sediment triad sampling shall be performed at Station 03 every five years starting from the year of the first effluent discharge event and every five years subsequently. Sediment triad sampling, as specified in the SQO - Part 1, consists of three lines of evidence (LOE) including: sediment chemistry, two toxicity tests and four benthic indices. See Section 4.3.1 – 4.3.4 for a description of the required LOEs.

In addition, sediment chemistry sampling shall be conducted in between the sediment triad sampling events every five years (ideally halfway between the five-year sampling period for the sediment triad sampling). The sediment chemistry samples shall be analyzed for the full chemical suite as included in Attachment A of the SQO-Part 1 to evaluate trends in general sediment quality constituents and listed constituents relative to sediment quality targets. Chemistry data without accompanying sediment triad data shall be used to assess sediment chemistry trends and shall not be used to determine compliance. If possible, the sediment quality objective evaluation as detailed in the SQO - Part 1, shall be performed every five years in coordination with the Biological Baseline and Bight regional monitoring programs[1].

If moderate sediment toxicity is observed, results shall be reported in the Annual Report and submitted to the LARWQCB. Further analysis and evaluation to determine the causes of toxicity and remedial actions shall be performed in accordance with the Executive Officer's approved monitoring plan. Table 4.3 presents marine sediment targets applicable to the Dominguez Channel Estuary.

Table 4.3 – Marine Sediment Targets

Organics	Marine Sediment Target (ug/kg)	Metals	Marine Sediment Target (mg/kg)
Chlordane, total	0.5	Cadmium	1.2
Dieldrin	0.02	Copper	34
Total PCBs	22.7	Lead	46.7
Benzo[a]anthracene	261	Mercury	0.15
Benzo[a]pyrene	430	Zinc	150
Chrysene	384		
Pyrene	665		
2-methlnapththalene	201		
Dibenz[a,h] anthracene	260		
Phenanthrene	240		
Total PAHs	4022		
Total DDT	1.58		

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[1] Biological Baseline and Bight regional monitoring programs are coordinated by the Southern California Coastal Water Research Project. Regional sediment quality monitoring occurs once every three years.

Sampling guidelines for assessing sediment composition and benthic community effects shall be performed in the Dominguez Channel Estuary following the guidelines specified in Section VII.E of the SQO Part 1.

Compliance with sediment TMDLs may be demonstrated by achieving the qualitative sediment condition of *unimpacted* or *likely unimpacted* via the interpretation and integration of Multiple Lines of Evidence (MLOE) as defined in the SQO-Part 1. Assessment of sediment quality shall consist of measuring and integrating data gathered from three lines of evidence (LOE) including sediment chemistry analysis, sediment toxicity and benthic community condition. Each LOE is described in the following sections.

4.3.1 Sediment Chemistry LOE

Sediment chemistry measures the concentration of chemicals in surface sediments and is used to assess the potential risk posed to benthic organisms from toxic pollutants. Sediment chemistry analysis is only intended to evaluate overall exposure risk from chemical pollutants. Two indices are used to interpret the results: the California Logistic Regression Model (CA LRM) and the Chemical Score Index (CSI). Results obtained from both indices are subsequently used to produce a single score representing the chemistry LOE.

4.3.2 Sediment Toxicity LOE

Sediment toxicity measures the response of invertebrates exposed to surface sediment under controlled laboratory conditions. Toxicity results are used to assess pollutant related biological effects and exposure and provides a measurement of exposure to all pollutants present, including non-traditional or unmeasured chemicals.

The toxicity LOE requires a short-term survival test and a sublethal test. The results of each test are categorized into nontoxic, low toxicity, moderate toxicity or high toxicity and are assigned a corresponding score. The two test scores are integrated to produce a single score for the sediment toxicity LOE.

4.3.3 Benthic Community Condition LOE

Benthic community effect measures the species composition, abundance and diversity of sediment dwelling invertebrates inhabiting surface sediments. Benthic community condition is used to assess impacts on benthic fauna and is intended to only evaluate overall exposure risk from chemical pollutants. The benthic condition is assessed using the following indices:

- Benthic response index (BRI)
- Index of Biotic Integrity (IBI)
- Relative Benthic Index (RBI)
- River Invertebrate Prediction and Classification System (RIVPACS)

The indices are analyzed together to provide an overall score for the benthic community condition LOE.

4.3.4 Integration of Multiple LOE

Assessment as to whether the aquatic life sediment quality objective has been attained at a monitoring station is accomplished by the interpretation and integration of MLOE. Evaluating both the chemistry and toxicity LOE determines the potential for chemically mediated effects. Similarly, evaluating both the toxicity and benthic community LOEs determines the severity of biological effects. Each LOE combination allows for the classification of each monitoring station into the following categories: unimpacted, likely impacted, possibly impacted, likely impacted, clearly impacted, or inconclusive.

4.4 Fish Tissue Monitoring

Fish tissue samples shall be collected every two years from the Dominguez Channel Estuary at Station 04. If no fish are available within the Estuary during a sampling event, the sampling location may be moved downstream to a location in close proximity to the Estuary (i.e. – northeast end of consolidated slip). Fish tissue samples shall be analyzed for chlordane, dieldrin, toxaphene, DDT and PCBs. Target species shall be selected based on residency, local abundance and fish size at the time of field collection. Tissues analyzed shall be based on the most common preparation for the selected fish species.

Selected fish species shall be collected by specialized contractors with the appropriate equipment to capture and prepare the fish tissue for analysis. Sampling locations are subject to change depending on field conditions during sampling events. Fish tissue samples shall be analyzed by Eurofins Laboratory. See QAPP Section 11.3 for a detailed description of fish species selection and procedures.

The fish tissue targets and the associated sediment targets for each pollutant, as specified in the Harbor Toxics TMDL, are summarized in Table 4.4. Fish tissue targets were determined from *Fish Contaminant Goals and Advisory Levels for Common Contaminants in California Sport Fish: Chlordane, DDTs, Dieldrin, Methylmercury, PCBs, Selenium and Toxaphene* developed by the Office of Environmental Health Hazard Assessment OEHHA (2008).[2]

Table 4.4 – Fish Tissue Targets and Associated Sediment Targets

Pollutant	Fish Tissue Targets (ug/kg wet)	Associated Sediment Target (ug/kg dry)
Chlordane	5.6	1.3
Dieldrin	0.46	n/a
Toxaphene	6.1	0.1
Total DDT	21	1.9
Total PCBs	3.6	3.2

Compliance with bio-accumulative TMDLs in fish tissue may be demonstrated via any of the following:

a. Fish tissue targets are met in species residents to the TMDL waterbodies.

b. Final sediment allocations based on sediment-fish tissue linkage in the Harbor Toxics TMDL are met.

c. Sediment numeric targets to protect fish tissue are met in bed sediments over a 3-year averaging period.

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[2] The Office of Environmental Health Hazard Assessment OEHHA (2008) assists agencies in developing fish tissue-based criteria for pollution mitigation or elimination and to protect humans from consumption of contaminated fish.

d. Demonstrate that the sediment quality condition protective of fish tissue is achieved per the Statewide Enclosed Bays and Estuaries Plan.

5.0 Sampling Procedures

Sample collection protocols, standard analytical procedures, quality assurance / quality control protocols for water and sediment monitoring are specified in the QAPP supporting this MRP.

6.0 Reporting Requirements

An Annual Report shall be submitted to the LARWQCB indicating compliance with waste load and/or load allocations. The annual monitoring report shall include the following:

- A description of monitoring activities conducted for the monitoring year;
- A summary of water, sediment and tissue analytical results;
- A summary of any deviations from the proposed sampling program and associated quality assurance / quality control issues and any associated action / response activities; and
- A summary of compliance / non-compliance with waste load allocations / targets.

Implementation of the Harbor Toxics TMDL monitoring program is triggered by the first storm water discharge from the facility through the permitted NPDES outfall into the Dominguez Channel Estuary. The monitoring year shall begin the day the first discharge from the facility is released and shall conclude one year thereafter. The Annual Report shall be submitted to the LARWQCB starting 15 months after monitoring is initiated and annually in subsequent years. All receiving water monitoring data shall also be submitted in accordance with the California Environmental Data Exchange Network (CEDEN). The facility shall submit all receiving water monitoring data in accordance with CEDEN, when feasible.

If no discharge occurs implementation of the TMDL monitoring program is not required and, as such, a no discharge report shall be submitted in the Annual Report submitted to the LARWQCB.

HARBOR TOXICS TMDL QUALITY ASSURANCE PROJECT PLAN (QAPP)

Prepared for:

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Prepared by:

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Date:

September 11, 2018

LOS ANGELES REFINERY – WILMINGTON OPERATIONS

QAPP REVISION HISTORY

Revision No.	Date	Revised By	Reason for Revision	Sections Revised
1.0	5/28/18	Ana Horn, QISP WGR Southwest, Inc.	Initial **DRAFT** QAPP preparation	All
2.0	8/14/2018	Ana Horn, QISP WGR Southwest, Inc.	Revised **DRAFT** plan in accordance with Regional Board comments	6.0, 6.1, 6.2, 9.0, 11.1, 12.3, 13.1, Appendix A, Appendix B, Appendix C and Appendix D

1.0 Title and Approval Sheets

Quality Assurance Project Plan approvals:

Name	Title	Signature	Date
Dave Foster	Vice President	D Foster	9/5/2018
Robert Nguyen	Environmental Manager		9-5-18
Amber Ballrot	Water Compliance Specialist		9-5-18
Ana Horn	Environmental Compliance Technician WGR, Southwest Inc.	Ana Horn	9-5-18

LOS ANGELES REFINERY -WILMINGTON OPERATIONS

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3.0 Distribution List

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2	WGR Southwest Inc. – Los Alamitos Office
3	Qualified Sampling Contractor

4.0 Project / Task Organization

As required by National Pollutant Discharge Elimination System (NPDES) No. CA0003778, Order R4-2017-0095, the Los Angeles Refinery – Wilmington Operations (herein facility) has developed a Quality Assurance Project Plan (QAPP) to support the facility's Monitoring and Reporting Plan (MRP) for the Harbor Toxics Total Maximum Daily Load (TMDL) Monitoring Program. The QAPP outlines monitoring and sampling methods, standard analytical procedures, laboratory certification requirements and quality assurance / quality control protocols. The QAPP consists of the following key elements:

1. Program Management;
2. Field sampling data quality objectives;
3. Laboratory quality objectives; and
4. Data review, verification and validation.

The goal of this QAPP is to ensure high quality data collection that allows for comparability to accurately define the existing conditions of the facility's receiving water.

4.1 Involved Parties and Roles

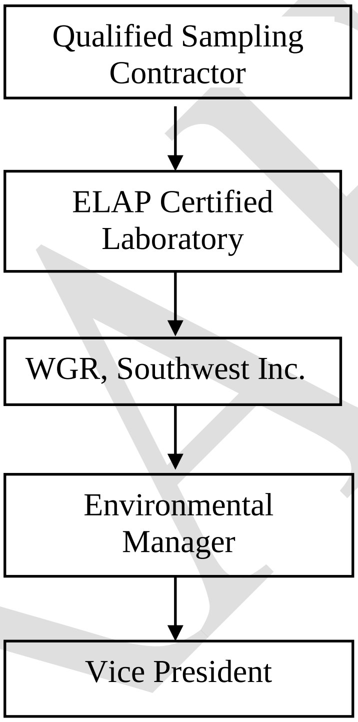
Facility officials, and qualified trained contractors undertake a collaborative approach to implement all aspects of this QAPP. The following outlines the involved parties, their tasks and responsibilities in implementing this program.

- Dave Foster is the Vice President of the organization who reviews and certifies all associated reports required to be submitted to the Los Angeles Regional Water Quality Control Board (LARWQCB) for the Harbor Toxics TMDL monitoring program. The vice president of the organization will not participate in the day to day execution of the program.
- Robert Nguyen is the Environmental Manager in charge of overseeing the storm water program implementation at the facility and approving facility effluent discharges to the NPDES outfall. The facility manager reviews field sampling activities, including sampling protocols followed by the designated sampling contractors, to ensure all sampling procedures comply with the facility's QAPP. The facility manager may stop all actions if there are significant deviations from required practices, or if there is evidence of systemic failure.

- WGR Southwest Inc. is the facility's Environmental Consultant that assists with reporting, plan preparation and provides technical assistance to facility personnel for storm water compliance issues. The environmental consultant is responsible for managing changes and updates to the facility's QAPP after a review of gathered data is assessed and all involved parties meet to discuss findings, deficiencies and any necessary changes applicable to the plan. Additionally, the environmental consultant is responsible for compiling field observations and analytical data from laboratories into a database, reviewing of the data for completeness and consistency.
- A select contractor shall be assigned to conduct field sampling for the facility's TMDL program. The contracted samplers shall be required to assign a designated supervisor to provide monitoring oversight in the field, provide progress reports to facility management and ensure all field sampling equipment is properly maintained. Contracted samplers are responsible for sample collection; handling and transport; and, field data transmittal to responsible parties.
- Contracted laboratories are responsible for delivering sample confirmation receipt notifications to facility management, performing the required analytical methods, following documentation, custody and sample logbook procedures, meeting all reporting QA / QC requirements, delivering electronic data files to facility management and meeting turnaround times for required analyses.

4.2 Project Organizational Chart

The facility’s MRP and QAPP shall be distributed to involved parties including the Environmental Manager, Environmental Consultant and Sampling Contractor. The sampling contractor is responsible for collecting samples and following the corresponding procedures outlined in the facility’s QAPP. Samples shall be submitted to a certified laboratory. Analytical results shall then be distributed to the Environmental Manager, and Environmental Consultant for review to account for any deficiencies, if any. Based on the information gathered, a monitoring report shall be generated and given to the Vice President for review and sign off to submit to the corresponding agency. The organizational chart below provides a summary of this pathway of information below:



5.0 Problem Statement / Background

The Clean Water Act Section 303(d) identifies impaired waterbodies for which effluent limitations are not meeting water quality standards. Water quality standards include the designated beneficial uses of a waterbody, the adopted water quality objectives to protect those uses, and the State's Antidegradation Policy. The 303(d) list identifies the Dominguez Channel Estuary as an impaired water body that fails to fully support its designated beneficial uses. The Dominguez Channel Estuary contains pollutant impairments for a variety of toxic pollutants, including metals, organic compounds and sediment toxicity; these impairments exist in the water column, sediment and/or fish tissue.

To protect and restore fish tissue, water and sediment quality, TMDLs for the Dominguez Channel Estuary have been designed to limit the amount of pollutants entering harbor waters. Target loads are specified in the TMDL program with the intent to determine the quantity of contaminants a system can assimilate while protecting water quality. Additionally, the TMDL strives to identify contaminant source inputs and linkages of inputs to impairments and allocate reductions to each pollutant source to achieve compliance with established targets for the restoration and protection of harbor waters.

The Wilmington Refinery is an individual industrial permittee allowed to discharge storm water into the Dominguez Channel Estuary under NPDES Permit No. CA0003778, Order No. R4-2017-0095. As such, the facility is required to develop a TMDL monitoring program to assess and characterize the pollutants present in the facility's receiving water.

6.0 Project Task Description

Data gained from water column, sediment and fish tissue samples in the Dominguez Channel Estuary shall be reported to the LARWQCB at the end of each monitoring year.

In addition, the facility shall utilize the analytical data to identify areas where waste load and/or load allocations are not being met, including identifying stressors and evaluating appropriate targets. Sampling shall occur at monitoring Stations 01, 03 and 04 as described in the facility's MRP and depicted in Figure 3, and Figure 4. The information gathered from the facility's TMDL monitoring program may be used by regulatory agencies to identify management actions that can be implemented to reduce sources and improve water quality as well as to plan for future monitoring needs and regulatory actions.

Monitoring shall include obtaining samples using Surface Water Ambient Monitoring Program (SWAMP) protocols and following the Sediment Quality Objectives (SQO) - Part 1 guidelines. Samples shall be collected by a qualified contractor specialized in sample field collection. Eurofins laboratory shall be used as the contract laboratory for analysis required under the Harbor Toxics TMDL Program. Eurofins Laboratory is an accredited laboratory with Environmental Laboratory Accreditation Program (ELAP) Certification No. 2944. As needed, Eurofins Laboratory shall subcontract to laboratories certified in accordance with the provision of Water Code Section 13176. ELAP certified analytical laboratories shall incorporate the corresponding QA/QC data to the analytical laboratory report. Pollutants must be analyzed using the analytical methods prescribed in 40 Code of Federal Regulations (CFR) 136.

6.1 Implementation Schedule

Implementation of the facility's MRP and QAPP shall begin from the facility's first discharge through the permitted NPDES outfall. Receiving water column sampling (including water samples and TSS samples) shall begin during or as soon as possible following the first effluent discharge event. Sediment and fish tissue monitoring must begin within the year of the first effluent discharge event. If *no discharge occurs, no monitoring shall be conducted in the Dominguez Channel Estuary and implementation of the facility's QAPP is not required.*

Monitoring shall include obtaining water column / TSS samples at Station 01 and 03, sediment samples at Station 03 only and fish tissue samples at Station 04. To assess temperature, dissolved oxygen, pH, electrical conductivity and receiving water flow, an appropriate calibrated field instrument shall be used by trained sampling personnel.

Table 6.1 summarizes water column, sediment and fish tissue requirements. Refer to Figure 3 and Figure 4 for the facility's monitoring stations.

Table 6.1 – Monitoring Requirements		
Medium	**Monitored Constituents**	**Frequency**
Water Column / TSS	Flow, Temperature, Dissolved Oxygen, pH, Electrical Conductivity, Lead, Zinc, Copper, DDT, PCBs, benzo[a]pyrene, benzo[a]anthracene, chrysene, phenanthrene, and pyrene.	3 Times / Year during: Two wet weather events[1] & One dry weather event
Sediment	Sediment chemistry, Two Sediment Toxicity Tests, and Four Benthic Indices	Every 5 Years[2]
Fish Tissue	Chlordane, Dieldrin, Toxaphene, DDT and PCBs	Every 2 Years

1 - The first large storm event of the season, once monitoring is triggered by a discharge from the facility, shall be included as one of the wet weather monitoring events. If no discharge occurs from the facility, implementation of the MRP and QAPP are not required.

2 - Sediment triad sampling shall be conducted every five years (starting from the year of the first effluent discharge event and every five years subsequently). Sediment chemistry shall include the constituents listed in Attachment A of the SQO-Part 1. Sediment triad sampling and sediment chemistry sampling shall occur at Station 03 only. In addition, sediment chemistry sampling shall be conducted in between the sediment triad sampling events every five years (ideally halfway between the five-year sampling period for the sediment triad sampling)

All field sampling and measurements shall be conducted as outlined in the SWAMP Standard Operating Procedure for the *Collection of Water and Bed Sediment Samples with Associated Field Measurements and Physical Habitat in California* (Appendix F) and SQO-Part 1 (Appendix G) sediment sampling procedures. Additional details about sample collection, handling and laboratory procedures are provided in QAPP, Section 12.

6.2 Deliverables

The facility's proposed MRP and QAPP plans are the first deliverables to the LARWQCB. Once approved and monitoring is initiated, monitoring reports shall be submitted to the LARWQCB annually. The first report is due 15 months after monitoring begins, and subsequent reports shall be submitted annually thereafter. If there is no discharge triggering the implementation of the facility's MRP and QAPP, no discharge shall be specified in the Annual Report.

Annual monitoring reports shall include a description of monitoring activities conducted for the monitoring year, a summary of water, sediment and fish tissue analytical results, summary of any deviations from the proposed sampling program and associated QA/QC issues, and any associated action/response activities. Annual monitoring reports shall provide a statement assessing whether or not monitoring results indicate compliance or non-compliance with waste load allocations / targets.

7.0 Quality Objectives and Criteria for Data Measurement

Data acquisition activities shall include both field measurements and laboratory analyses. The following indicators shall be used to assess data quality: accuracy, precision, representativeness, comparability and completeness. These indicators and data quality objectives shall be used to determine the level of error considered to be acceptable in the data produced by the sampling program. The following provides a brief discussion of the objectives for the indicators used in this monitoring program.

7.1 *Accuracy (Bias)*

Accuracy is a measurement of how closely analytical results correspond to a “true” or accepted value. To achieve accuracy in measurements of pH, dissolved oxygen, electrical conductivity, and temperature, the corresponding measurement device shall be calibrated before each sampling event. Additionally, the laboratory is to address accuracy during sample analysis by evaluating the percent recovery of surrogates, laboratory control samples (LCS) and / or matrix spikes (MS).

7.2 *Precision*

Precision is a measurement of how closely analytical results can be duplicated. Precision is addressed by the collection and analysis of replicate samples. Additionally, the laboratory duplicates shall be analyzed to assess laboratory precision, which is reported as a standard deviation or relative percent difference (RPD).

7.3 *Representativeness*

Representativeness describes the degree to which the results of analyses represents the samples collected and the samples representation of the environment from which they are taken. Determining appropriate sample locations, utilizing approved documents and standard operating procedures and analytical methods shall ensure that field conditions are represented as best as possible. It is important to note that because site conditions may be affected by flow, tidal cycles, weather conditions, etc. field observations and conditions shall be noted during each sampling event.

7.4 *Comparability*

Comparability is the similarity of data from different sources. To appropriately compare data from multiple sampling events, standard methods of sample handling and analysis must be used. Maintaining consistency in the standard methods used eliminates variables that might result in unusable data.

7.5 *Completeness*

Completeness is the percentage data available for use compared to the potential amount of data identified in the monitoring plan. Ideally, 100% of the data should be available, however, possibilities exist for issues to arise that may result in incomplete data sets. These include unexpected field conditions, laboratory error, and shipment complications that result in unacceptable sample preservation conditions. To minimize data loss, facility management shall review all collection protocols and field measurements and implement corrective actions, if needed.

8.0 Special Training / Certification

Sampling personnel shall have prior experience and training in the type of water quality monitoring proposed for this program. The designated contract sampling supervisor shall ensure personnel are trained and familiar with the facility's MRP and QAPP.

Contracted laboratories must be certified by the Environmental Laboratory Accreditations Program (ELAP) in accordance with provision of Water Code Section 13176. The assigned laboratory shall have their own QA/QC program in place to ensure requisite knowledge and skills are in place for the proper execution of the analytical methods being requested.

Involved parties responsible for implementation of this QAPP shall ensure all necessary standard operating procedures are followed for the duration of the program. All involved parties must completely understand the QAPP and retain an up to date copy for reference.

9.0 Documentation and Records

Records of all monitoring information, including calibration and maintenance records, copies of all reports and records of all data shall be maintained for a minimum of three (3) years.

All field measurements shall be recorded at the time of completion using standard field data sheets. The data sheets shall be reviewed at each monitoring station to ensure all information required is complete. If data is missing an explanation must be recorded documenting the reason for incompleteness. The following information shall be recorded at each monitoring station:

- Monitoring station ID / location
- The date and time of sample collection
- Name of individuals collecting the samples
- Field observations / site conditions
- GPS coordinates
- Field measurements
- Number and types of samples collected
- Additional information that may affect the integrity of the samples

Laboratory personnel are responsible for documenting all analyses performed. Reporting shall include:

- The date(s) analyses were performed;
- The analytical techniques or methods used;
- The results of such analysis;
- Names of the personnel who performed the analysis;
- Final laboratory analytical reports;

- Analytical and extraction methods;
- Summary of QA/QC data, including matrix spikes, laboratory control samples, duplicate analyses, blanks, blank spikes, percent recovery of surrogates, etc. (Level 2 QA/QC); and,
- A perjury statement executed by the person responsible for the laboratory.

Analytical results received from the laboratory shall be reported to the LARWQCB. An Annual Report on the findings of the monitoring program shall be developed and submitted at the end of the monitoring year.

All of the above information shall be reviewed by qualified personnel to ensure that proper analytical methods and procedures were followed. The information shall be reviewed, specifically, to determine if the samples were analyzed using the proper analytical methods and within the appropriate holding times, and if the QA/QC data is within allowable limits set by the laboratory. All QA/QC items must be run on the same dates the samples were actually analyzed. Duplicate and spike samples shall be analyzed at the frequency specified in the applicable analytical method; if the method does not specify a frequency, duplicate samples and spike samples shall be analyzed at a frequency of 5% (1 in 20 samples) with at least one if there are fewer than 20 samples in a batch. A batch is defined as a single analytical run encompassing no more than 24 hours from start to finish.

Each sample result must specify the applicable reporting limit (RL) and the Method Detection Limit (MDL) for each parameter, as determined by the procedure in 40 CFR Part 136. If there are any discrepancies in the laboratory data, the laboratory shall be contacted to discuss the discrepancies. An explanation for the discrepancies should be included in the annual report. In addition, the QAPP shall be reviewed and revised annually based on the results and execution of the program during the reporting year. Revisions shall be made by the facility's environmental consultant and the changes shall be reviewed and approved by the facility manager. An updated copy of the plan shall be redistributed to the parties involved in the execution of the facility's QAPP.

Group B: Data Generation and Acquisition

10.0 Sampling Process Design

The monitoring station locations for water, sediment and fish tissue samples are summarized in Table 10.0. A total of 3 stations are included in the compliance monitoring program. All monitoring stations were selected based on the locations specified in Attachment A to Resolution No. R11-008 (Appendix H). Samples shall be collected by designated specialized contractors that have the required equipment and tools to properly collect and process the required samples. Sampling efforts shall include gathering data of onsite conditions, obtaining water quality measurements and collecting grab samples for analysis of the required parameters.

Samples shall be collected in clean sample containers that are made of appropriate materials, have adequate volume, and contain the correct preservative required for analysis as provided by the laboratory. Appendix D provides the Chain of Custody (COC) for water column, sediment and fish tissue analyses.

Table 10.0 – Sample Stations

Water Body Name	Station ID	Station	Station Location	Sample Media and Parameters[1]
Dominguez Channel Estuary	01	Discharge Point 001 Station	33 ° 47’33.45” N 118 13’48.88” W	**Water Column / TSS:** Lead, Zinc, Copper, PCBs, DDT, benzo[a]anthracene, benzo[a]pyrene, chrysene, phenanthrene, and pyrene, temperature, dissolved oxygen, pH, electrical conductivity and receiving water flow
	03	Discharge Point 003 Station	33 ° 47’08.39” N 118 14’05.95” W	**Water Column / TSS:** Lead, Zinc, Copper, PCBs, DDT, benzo[a]anthracene, benzo[a]pyrene, chrysene, phenanthrene, and pyrene, temperature, dissolved oxygen, pH, electrical conductivity and receiving water flow **Sediment:** Sediment Chemistry[2], Toxicity, Benthic Community Effect
	04	Fish Tissue Sampling Station[3]	33 ° 46’40.94” N 118 ° 14’24.01” W	**Fish Tissue:** Chlordane, Dieldrin Toxaphene, DDT and PCBs

1 – Sampling shall be designed to collect sufficient volumes of suspended solids to allow for analysis of the listed pollutants in the bulk sediment.
2 – Sediment bed samples shall be collected at Station 03 only. Sediment chemistry samples shall be analyzed for the full chemical suite as included in Attachment A of the SQO-Part 1.
3 – Fish tissue sampling location is subject to change depending on receiving water conditions. If no fish are available within the Dominguez Channel Estuary during a sampling event, the sampling station may be moved downstream to a location in close proximity to the Estuary (i.e. – northeast end of consolidated slip).

In the event a sampling site becomes inaccessible, documentation shall be maintained for that particular sampling location noting the conditions hindering access to the location.

Samples shall be targeted for collection 24 hours after a storm event to allow for runoff to reach the receiving waters and to improve the likelihood of sampling in less dangerous conditions than those present at the start of a storm.

11.0 Sampling Methods

The following protocols describe the techniques to be used to collect field samples in a way that neither contaminates, loses or changes the chemical form of the analytes of interest. All samples shall be collected using boats equipped with specialized equipment as provided by the contracted sampling company. Samples shall be collected in areas where the vessel does not interfere with the water being collected. The procedures for collecting field samples shall follow the SWAMP standard operating procedure for *Collection of Water and Bed Sediment Samples with Associated Field Measurements and Physical Habitat in California* (Appendix F) and the SQO – Part 1 (Appendix G) sediment sampling procedures.

11.1 Water Column and TSS Sample Collection

Water quality monitoring shall consist of field measurements and the collection of water samples for chemical analyses. All field instruments shall be calibrated per manufacturer's instructions. Calibrations shall be documented and maintained on file. Each instrument used to collect field measurements must be allowed to completely equilibrate before recording measurements.

Water column samples shall be collected from the surface during two wet weather events and one dry weather event, and analyzed for the required metals, PCBs, DDT and PAH constituents as noted in Table 10.0. For each sampling event, Station 01 and Station 03 shall be monitored for pH, temperature, dissolved oxygen, electrical conductivity and flow using the appropriate field equipment. Field measurements, including water depth, shall be recorded on a field datasheet. Additionally, TSS samples shall be collected at different depths (surface, mid-water column and bottom) within the water column.

Surface samples are defined as samples collected between 0 and 1 meter. Mid water column samples are defined as samples collected at 50% of the total depth of the sampling location. The overall water depth shall be determined in the field during the time of sampling to account for changes of the water column depth that may result from uncontrollable factors, such as tidal patterns, seasonal fluctuations, input from precipitation / loss from evaporation, etc. Bottom sample depths are those samples collected within 1 meter above the bed of the estuary.

TSS samples collected at different depths shall be consolidated into one sample for analysis of the pollutants in the bulk sediment. Proper gloves must be worn to prevent contamination of the samples and to protect the sampler from environmental hazards. A manual containing the standard operating procedures for all field analyses, including records of instrument calibration and maintenance, and quality control procedures shall be maintained on site. Refer to Appendix F for detailed SWAMP sampling protocols.

11.2 Sediment Sample Collection

Assessment of sediment quality shall consist of measuring and integrating data gathered from three lines of evidence (LOE), as specified in the SQO – Part 1, including sediment chemistry analysis, sediment toxicity and benthic community condition.

Sediment samples shall be collected at Station 03 with the use of a mechanical sediment Van Veen grab sampler. The grab sampler must be slowly lowered to the bottom with minimum substrate disturbance. Surface sediment shall be obtained within the upper 5 cm for chemistry and toxicity analyses. Benthic samples shall be screened through a 1.0 mm mesh and the entire contents of the grab sample, with a minimum penetration depth of 5 cm, shall be collected for benthic community analyses. Once sediment has been collected, the grab sampler shall be retrieved at a moderate speed.

Upon retrieval, the grab sample must be examined to ensure that the sediment surface is undisturbed and that the grab sample is not subject for rejection. The sample must be rejected if the following are not met:

- Mud surface must not be pressing out of the top of the sampler
- Water must not be leaking out along the sides of the sediment in the grab sampler (this ensures the surface sediment is not washed out)
- Sediment surface must be flat and level in the sampler (if it is not level, the grab tilted over before closing).

The sediment sampler must be cleaned prior to sampling EACH monitoring station, and processing of the sediment sample must be performed with reference to SWAMP protocols.

11.3 Fish Tissue Sample Collection

Fish tissue monitoring shall be conducted within the Dominguez Channel Estuary at Station 04 only. If no fish are available in the Estuary's established location during the sampling event, the fish tissue station may change to a location downstream of Station 04 in close proximity to the Estuary (i.e. northeast end of consolidated slip). Target species shall be selected based on residency, local abundance and fish size at the time of field collection. Tissues analyzed shall be based on the most common preparation for the selected fish species.

Fish selection shall be contingent upon the following considerations:

- The fish selected should be one fished in the harbor;
- The fish selected should have a fish consumption advisory or demonstrate elevated concentrations of PCBs and DDT within its tissue;[3] and
- The fish must be abundant in the water body of interest.

In general, filet muscle tissue with the skin off will be used for analysis. Dissection and compositing of muscle tissue will be performed following USEPA guidance[4] and/or Bioaccumulation Oversight Group[5] (BOG) protocols. Dissection and compositing methods will be performed in the analytical laboratory. Fish collected shall be visually observed, measured and wrapped in aluminum foil and placed in a waterproof plastic bag that is labeled or tagged appropriately. Packaged individual specimens in a composite sample

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[3] For fish consumption advisories refer to the Environmental Health Hazard Assessment (OEHHA) website: https://oehha.ca.gov/

[4] USEPA. 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories: Volume 1, Fish Sampling and Analysis. US Environmental Protection Agency. Office of Water. Washington DC.

[5] The Bioaccumulation Oversight Group (BOG) is a subcommittee of the SWAMP Roundtable that provides oversight of SWAMP's state-wide bioaccumulation monitoring program.

should be kept together, if possible. Once packaged, samples should be cooled on ice immediately.

Every effort shall be taken to ensure that any sampling technique occurs within the proposed target sampling areas. Numerous factors such as wind, currents, and presence or absence of targeted fish species may require the collection of fish outside the boundaries of the target monitoring station locations. All available resources shall be used if insufficient fish have been caught at target locations. Fish finders or echo sounders can be used to find alternative sampling locations that is as close as practicable to the original monitoring station and still within the waterbodies specified in the Harbor Toxics TMDL. Reasons for relocation and/or any other observations must be noted in the field log.

11.4 Corrective Actions

If problems arise during sampling events, samplers shall document the deficiencies and report to the assigned supervisor. The supervisor shall then be communicated with facility officials to implement corrective actions and avoid future occurrences.

12.0 Sample Handling, Preservation, and Custody

12.1 Sample Collection and Initial Preservation

Sample collection includes all stages of sampling directly connected with capturing the sample, assuring that the sample is a true representation of the medium and preventing cross contamination. The following sections describe sample handling procedures to be followed throughout this program.

12.2 Sample Labels

Each sample must be labeled with labels provided by the laboratory and contain the following information:

- Facility Name:
- Monitoring Station / Location
- Initials of Sampling Personnel
- Date and time of collection
- Preservative present in container (i.e. hydrochloric acid “HCl”)
- Analysis to be performed

12.3 Sample Log / Sample Collection Information

General sampling information is recorded on the Chain of Custody at the time of sampling in sufficient detail so that such information can be readily available. Sampling information recorded on the Chain of Custody includes:

- Facility Name
- Sample Point Location Name
- Signature and Printed Name of Person Responsible for Sampling
- Sample ID

- Sample Date/Time
- Preservatives Added
- Field Measurement Results
- Signature and Printed Name of Person Responsible for Receiving the Samples

12.4 Chain of Custody Procedures

The chain of custody form documents sample possession from the time of collection until the sample is analyzed. It also serves as a sample inventory and an analysis order form. Once the chain of custody record is received by the laboratory it is checked for accuracy and completeness. Information for each sample including the sample number, date of sampling, time of sampling, the sample matrix, and the required analyses, is entered on the form. The form should be filled out with a waterproof pen after the samples are labeled and ready for shipment. To keep it dry, the chain of custody record should be placed in a sealed plastic bag and sent to the laboratory inside the sample cooler. Facility personnel are responsible for retaining a copy of the original chain of custody.

12.5 Analytical Information

The facility personnel or an authorized contractor must properly collect, pack and document the sample collection utilizing applicable methods and procedures. Once the samples have been collected and prepared for shipment to the laboratory, the authorized and qualified sampling contractor shall contact the appropriate laboratories for sample pickup or coordinate sample drop off to the laboratory. Various analyses have different hold times (the maximum time allowed between the collection and analysis of a sample). Samples must be transported to the laboratory as soon as possible, but no more than **24 hours** after sample collection to avoid exceeding any holding times.

Sample containers and holding conditions for the required constituents required under this monitoring program are provided in Appendix A. A list of analytical methods, reporting limits and method detection levels of the laboratory analyses for each medium are included in Appendix B and the corresponding target concentration for these parameters as provided in Attachment A to Resolution No. R11-008 are included in Appendix C.

13.0 Analytical Methods

This section describes the management of the samples after collection. Included in this section are sample preservation techniques, sample storage, descriptions of the analyses and parameters to be analyzed, the appropriate analytical methods to be used, required documentation, and the proper quality assurance/quality control (QA/QC) procedures to follow.

13.1 Analytical Methodology

The analytical methods for all analyses are listed in Appendix B. Duplicate and spike samples shall be analyzed at the frequency specified in the applicable analytical method; if the method does not specify a frequency, duplicate samples and spike samples shall be analyzed at a frequency of 5% (1 in 20 samples) with at least one if there are fewer than 20 samples in a batch. A batch is defined as a single analytical run encompassing no more than 24 hours from start to finish.

13.2 Sample Preservation and Storage

Sample preservation is dependent on the specific analyses that are to be performed. Each sample is to be collected in sample containers provided by the laboratory. The required analyses call for different preservation techniques. The laboratory provides the proper containers with the appropriate preservatives already added to the containers. Field measurement of pH, temperature, dissolved oxygen, electrical conductivity, and flow may be field-tested by the sampler, using the appropriate instrumentation. A summary of preservation techniques is included in Appendix A, including sample bottles and holding times.

Sample storage is an integral part of the sample preservation. The samples are to be stored until they are transported to the laboratory at a temperature of 4 degrees Celsius either in a refrigerator or on ice in a cooler. A summary of storage temperatures is also included in Appendix A.

14.0 Quality Control

To ensure high quality data, all parties involved in executing the facility's QAPP shall adhere to the standard operating procedures and methods as specified in the plan. Field and laboratory data generated during this TMDL monitoring program shall be reviewed using the data quality objectives described in Section 7.0 for the duration of the monitoring program, from the point of collection though laboratory analysis and reporting. Corrective actions shall be implemented when sample collection or analysis deficiencies are identified. Corrective actions involve checking procedures, reviewing documentation and calculations to identify possible errors, and re-analyzing samples, if possible.

The facility's QA/QC program is designed to ensure that all elements of the QAPP are implemented and that they are implemented by properly trained personnel. Each person who shall perform or supervise sampling and/or perform discharge point inspections (storm and dry season) in accordance with this program must have a working knowledge of this plan, be familiar with the facility's MRP, and be otherwise qualified to carry out the associated tasks. Each of these persons shall receive a copy of this program for their review and shall be trained on the requirements of this monitoring plan and proper sample collection and water quality monitoring practices. All monitoring conducted in compliance with the MRP must be comparable with the Quality Assurance requirements specified in SWAMP.

15.0 Instrument / Equipment Maintenance and Calibration

Field equipment shall be maintained in accordance with manufacturer specifications. Maintenance shall be provided on an as needed basis. Prior to each sampling event, all instruments required shall be inspected during calibration procedures. All equipment must be tested for appropriate responses prior to analysis. Any deficiencies shall be identified, and corrective actions implemented. All equipment and instruments that may come into contact with sampling media must be properly cleaned prior to each use and between sampling events to prevent cross contamination between samples. The following procedure shall be implemented to ensure the sampling equipment is properly cleaned:

1. Pre-wash rinse of sampling equipment with tap or site water
2. Wash sampling equipment with warm tap water or site water and specialized soap[6] solution
3. Rinse using tap or site water
4. Rinse thoroughly with organic free water and place on a clean foil wrapped surface to air dry
5. Store in a clean, closed container for next use

After decontamination, equipment should only be handled by personnel wearing clean gloves to prevent re-contamination. All equipment shall be stored in clean containers away from the decontamination area to prevent re-contamination. When sampling each station, gloves must be worn at all times and shall be discarded after processing each station. Gloves must be replaced prior to handling decontaminated instruments or work surfaces.

Contract laboratories and sampler contractors are responsible for maintaining analytical and sampling equipment in accordance with their standard operating procedures, including those specified by the manufacturer and the analytical methods used. If contractor equipment malfunctions, facility officials must be notified, and data is not to be collected or analyzed using the deficient instrument. All problems and corrective actions must be recorded by the contract laboratory and samplers. Facility officials must address any problems identified during sampling events and update the QAPP accordingly.

16.0 Data Management

Involved parties responsible for the implementation of this QAPP are to maintain all data records, including field generated data and laboratory data. Results obtained during this monitoring program must be reported in the annual monitoring report to be submitted to the LARWQCB. All receiving water monitoring data shall also be submitted in accordance with the California Environmental Data Exchange Network (CEDEN). The discharger shall submit all receiving water monitoring data in accordance with CEDEN, when feasible.

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[6] Specialized soap used for washing equipment shall consist of detergent ideal for cleaning contaminants from glassware, metals, and plastic equipment, such as Alconox™ soap.

Group C Elements: Assessment and Oversight

17.0 Assessment and Response Actions

During sample collection events, samplers must review the appropriate standard operating procedures before going out to the sites to collect samples to ensure all methods are understood and the necessary equipment and supplies are ready for use. All measurements obtained in the field and all collected samples shall be visually evaluated to ensure all information required in the field data sheets is gathered prior to leaving a monitoring station. If issues are identified, the facility manager shall be notified, and appropriate actions shall be taken. Documentation of any deficiencies is to be recorded and maintained on site. Deficiencies must be noted in the Annual Report submitted to the LARWQCB.

Group D Elements: Data Validation and Usability

18.0 Data Validation and Usability

This section addresses the quality assurance activities that occur following the completion of sampling activities, including data review, verification and validation. Data generated for this monitoring program shall be reviewed against the data quality objectives specified in this QAPP. Field, laboratory and facility personnel shall be responsible for reviewing the data and verifying that sample collection, handling and analysis procedures were in accordance with the methods specified in this plan and its attached sampling protocols found in Appendix F and Appendix G.

Data verification and validation for sample collection and handling activities shall consist of the following tasks:

- Verification that the sampling activities were performed in accordance with QAPP requirements;
- Documentation of any field changes or discrepancies;
- Verification that the field activities were properly documented;
- Verification of proper completion of sample labels and secure storage of samples; and
- Verification that all samples recorded in the field log were received by the laboratory.

Data verification and validation for the sample analysis activities shall consists of the following tasks:

- Appropriate methodology has been followed;
- Instrument calibrations are correct;
- QC samples meet performance criteria;
- Analytical results are complete and correct; and
- Documentation is complete.

Analytical laboratory result copies shall be emailed to all involved parties responsible for implementation of the QAPP. Sample results shall be evaluated immediately upon receipt by the facility officials and the environmental consultant.

19.0 Reconciliation with User Requirements

The data quality shall be evaluated according to this document, with respect to sampling design, sampling method, field and laboratory analyses, quality control and maintenance. By properly following the guidelines in this document and documents referenced the data quality shall be validated. If samples or procedures used in this study fail to meet the guidelines listed in this document, the data shall be flagged and reported to the facility manager and associated parties responsible for the implementation of this QAPP. Any flagged data shall be carefully scrutinized to determine areas of improvement that shall improve data quality and usability.

FIGURE 1:

VICINITY TOPOGRAPHIC MAP

FIGURE 1
VICINITY TOPOGRAPHIC MAP

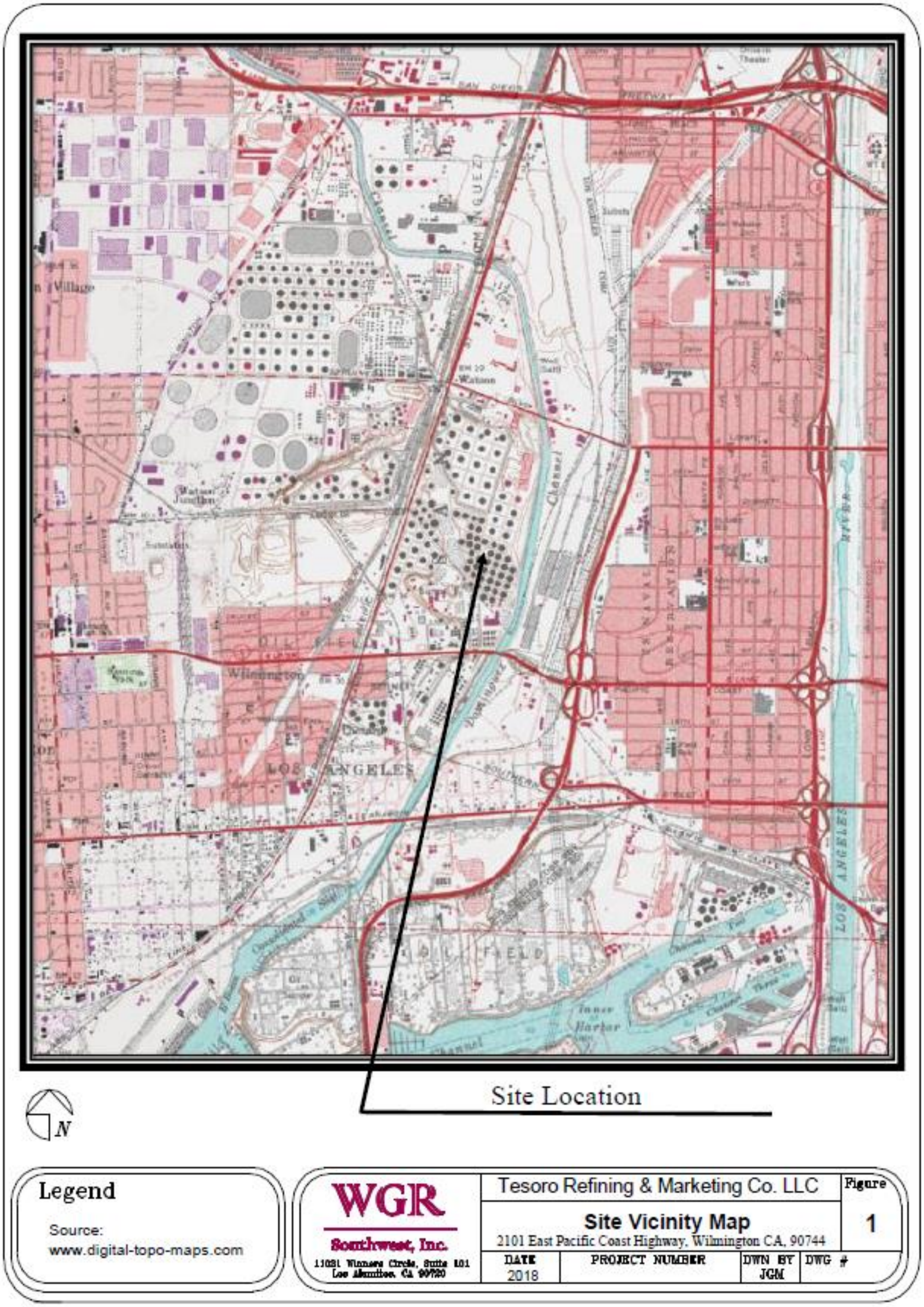
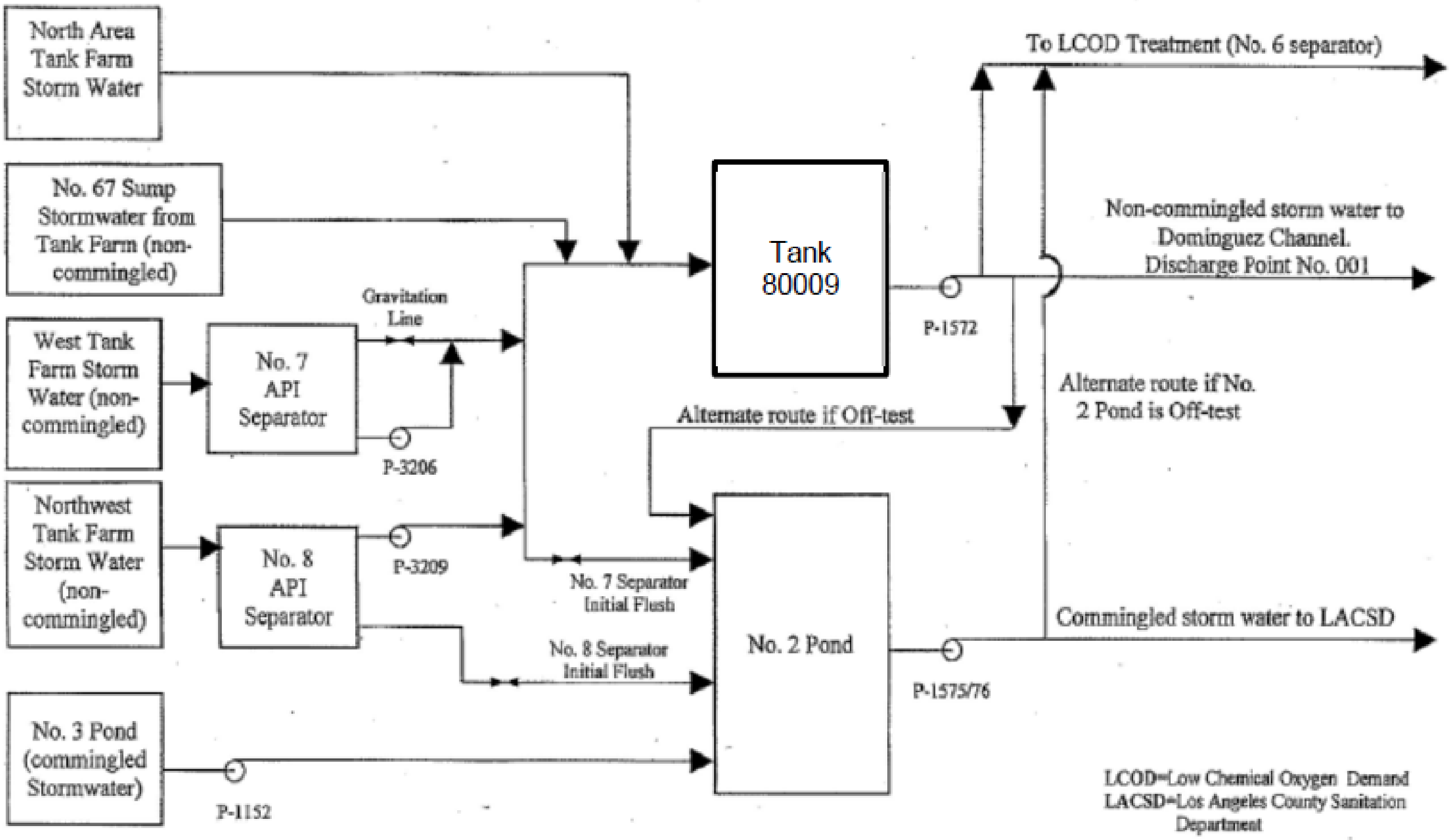


FIGURE 2:

FACILITY FLOW DIAGRAM

Storm Water System



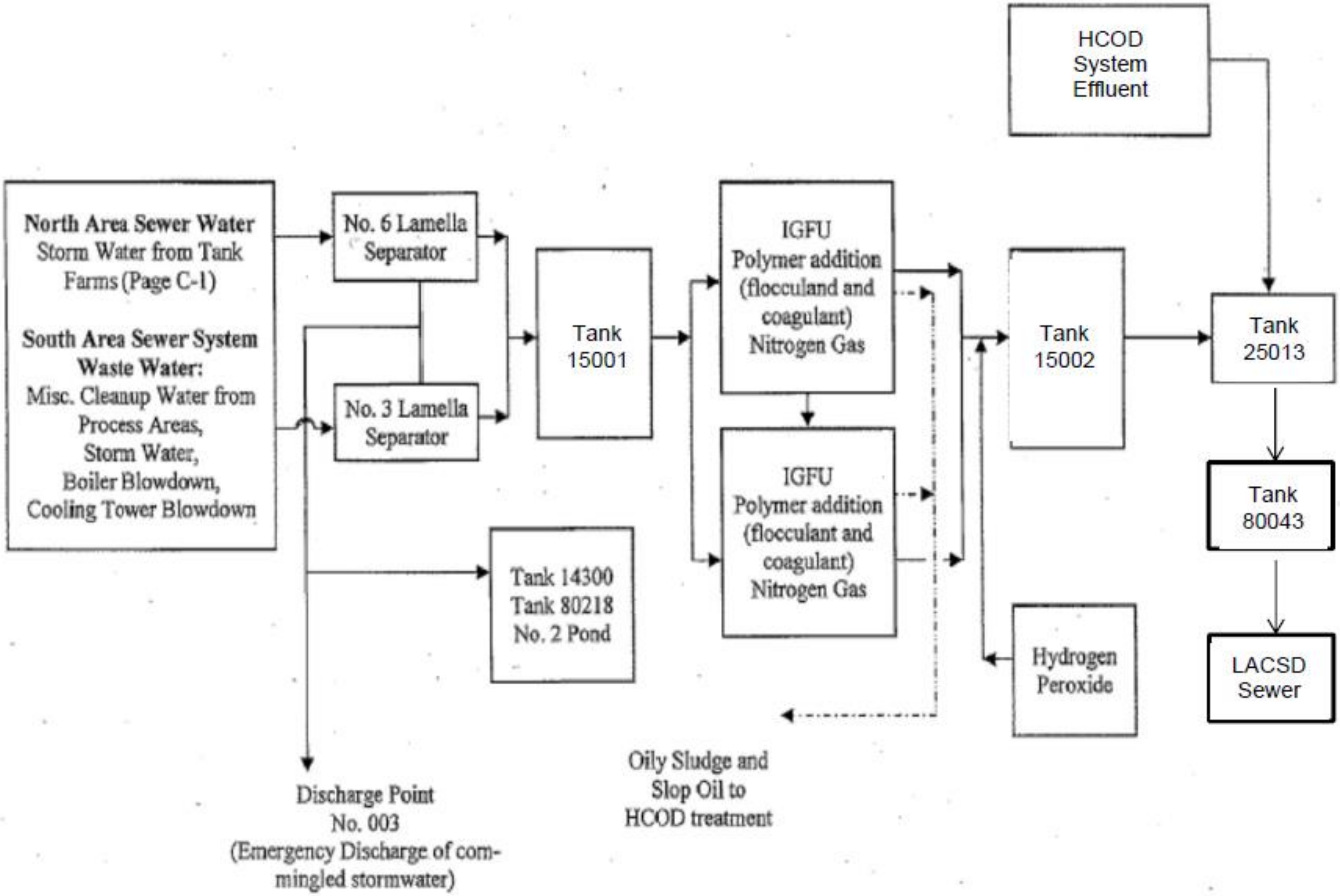

North Area Sewer Water
Storm Water from Tank Farms (Page C-1)
South Area Sewer System Waste Water:
Misc. Cleanup Water from Process Areas,
Storm Water,
Boiler Blowdown,
Cooling Tower Blowdown
No. 6 Lamella Separator
No. 3 Lamella Separator
Tank 15001
Tank 14300
Tank 80218
No. 2 Pond
Discharge Point No. 003 (Emergency Discharge of com-mingled stormwater)
IGFU Polymer addition (flocculand and coagulant) Nitrogen Gas
IGFU Polymer addition (flocculant and coagulant) Nitrogen Gas
Oily Sludge and Slop Oil to HCOD treatment
HCOD System Effluent
Tank 15002
Hydrogen Peroxide
Tank 25013
Tank 80043
LACSD Sewer

FIGURE 3:

HARBOR TOXICS TMDL
DOMINGUEZ CHANNEL ESTUARY
MONITORING LOCATION

Los Angeles Refinery – Wilmington Operations

Figure 3 – Harbor Toxics TMDL Dominguez Channel Estuary Monitoring Locations

LEGEND

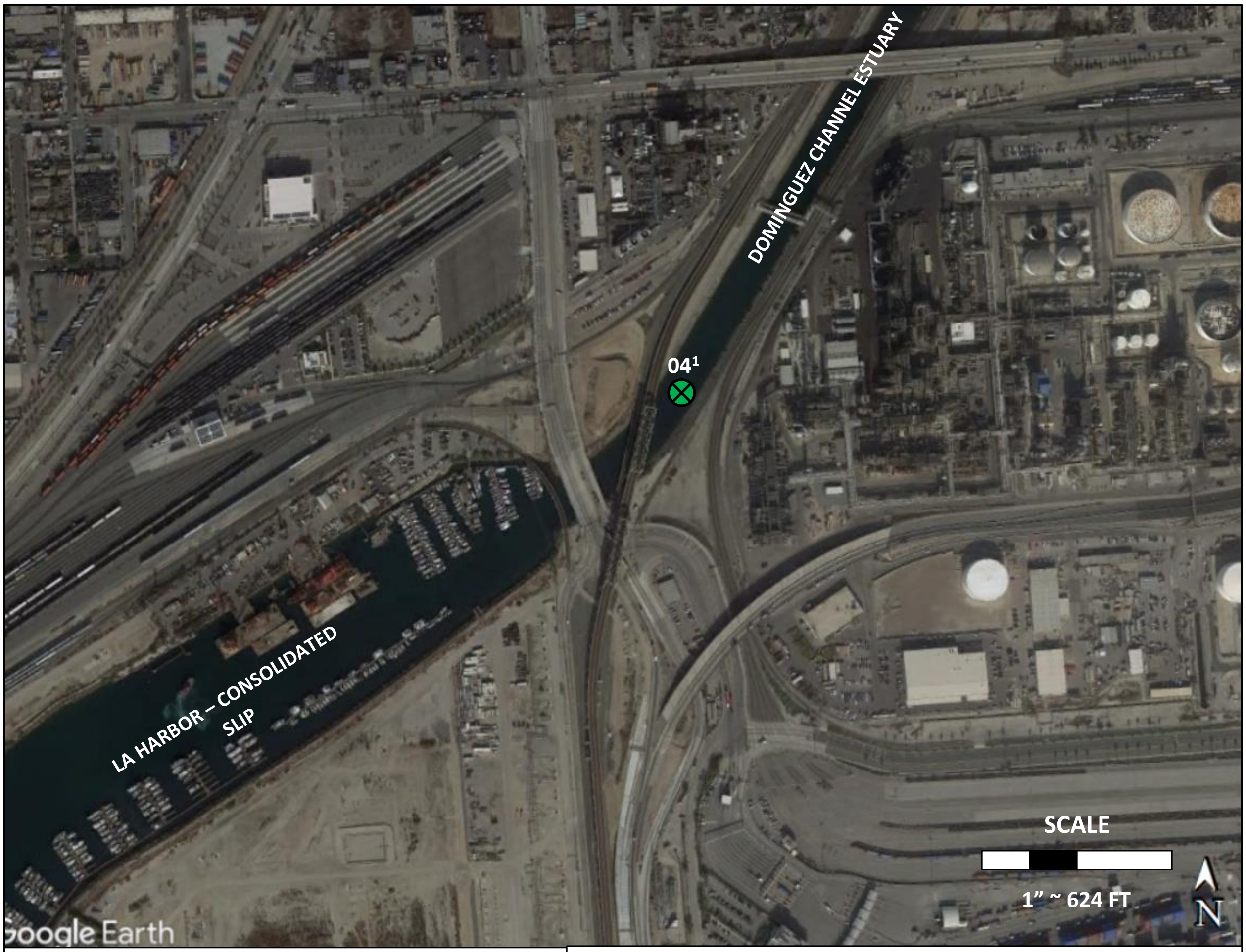
⊗ Water Column / TSS Sampling Station 01

⊗ Water Column / TSS, and Sediment Sampling Station 03

WGR
Not Your Typical Consultant

FIGURE 4:

HARBOR TOXICS TMDL DOMINGUEZ CHANNEL ESTUARY FISH TISSUE MONITORING LOCATION



Tesoro Refining & Marketing Company LLC
Los Angeles Refinery – Wilmington
Operations

Figure 4 – Harbor Toxics TMDL Fish Tissue Monitoring Station

LEGEND:

⊗ Fish Tissue Monitoring Location 04

NOTES:

[1] The fish tissue monitoring station is subject to change depending on sampling conditions. If no fish are available in the Dominguez Channel Estuary during sampling events, the fish tissue sampling location may be moved downstream in close proximity to the Estuary.

APPENDIX A:

SAMPLE CONTAINERS
AND HOLDING CONDITIONS

Appendix A: Sample Containers and Holding Conditions[1]

Parameter	Container Type / Volume	Holding Time	Preservative
Water/TSS Samples[2]			
pH	N/A	15 minutes	N/A
Dissolved Oxygen	N/A	15 minutes	N/A
Electrical Conductivity	1 - 125 mL HDPE	28 days	None
Metals: Copper, Lead and Zinc	1 - 250 mL HDPE	180 days	HNO3 ; Cool ≤4°C
DDT	2 - 1L Amber Glass	7 days	Cool ≤4°C
PCBs	2 - 1L Amber Glass	7 days	Cool ≤4°C
PAHs: Benzo[a]anthracene, Benzo[a]pyrene, Chrysene, Phenanthrene, Pyrene	2 - 1L Amber Glass	7 days	Cool ≤4°C
Sediment			
Total Organic Carbon	1- 4-oz glass with teflon lid	14 days	Cool ≤4°C
Metals	1 - 4-oz glass with teflon lid	14 days	Cool ≤6°C
		12 months	Freeze ≤ -20°C
Mercury	1 - 4oz glass with teflon lid	14 days	Cool ≤6°C
		12 months	Freeze ≤ -20°C
DDT	1 - 4-oz glass with teflon lid	14 days	Cool ≤4°C
PAHs	1 - 4-oz amber glass with teflon lid	14 days	Cool ≤4°C
PCBs	1 - 4-oz glass with teflon lid	14 days	Cool ≤4°C
Benthic Community Effect[3]	1 - 0.5-gallon poly container	None	Cool ≤4°C
Sediment Toxicity	4 - 1L wide mouth polyethylene with teflon lid liner	14 days	Cool ≤4°C
Fish Tissue			
DDT	Polyethylene bag or 4-oz glass jar	14 days to extraction	Cool ≤6°C
		1 year to extraction; samples must be extracted within 14 days of thawing	Freeze ≤ -20°C
		40 days after extraction	Cool ≤6°C
PCBs	Polyethylene bag or 4-oz glass jar	None	Cool ≤6°C within 24 hours, then Freeze ≤ -20°C

1- Sample preservation is intended as a guidance only. The selection of sample container and sample volume may vary per contracted / subcontracted laboratories.

2 - Water column analysis of flow, temperature, dissolved oxygen, electrical conductivity and pH shall be conducted in the field using the appropriate calibrated field equipment. A record of the calibration and the field readings shall be documented in the appropriate form.

3 – Samples for benthic community effect are preserved in the field by maintaining samples cold. Once submitted to the laboratory, samples are stored in formalin for at least 72 hours and then samples are maintained in 70% ethanol. Samples can be stored for up to 1 year before having to refresh the ethanol.

APPENDIX B:

ANALYTICAL METHODS, REPORTING LIMITS AND METHOD DETECTION LEVELS

Appendix B: Analytical Methods, Reporting Limits and Method Detection Levels[1,2]

Parameter	Analytical Method	Method Detection Levels	Reporting Limit	Units
WATER COLUMN / TSS ANALYSIS				
Copper	EPA 6020	0.117	1.0	ug/L
Lead	EPA 6020	0.0543	1.0	ug/L
Zinc	EPA 6020	4.49	5.0	ug/L
DDT				
o,p'-DDT	USEPA 1699	0.0000172	0.00004	ug/L
p,p'-DDT	USEPA 1699	0.0000172	0.00004	ug/L
PAHs				
Benzo[a]anthracene	USEPA 8270C	0.024	0.20	ug/L
Benzo[a]pyrene	USEPA 8270C	0.036	0.20	ug/L
Chrysene	USEPA 8270C	0.019	0.20	ug/L
Phenanthrene	USEPA 8270C	0.031	0.20	ug/L
Pyrene	USEPA 8270C	0.025	0.20	ug/L
PCBs[3]				
PCB008	EPA 1668	0.000034	0.0001	ug/L
PCB018	EPA 1668	0.000007	0.0002	ug/L
PCB028	EPA 1668	0.000004	0.0002	ug/L
PCB044	EPA 1668	0.000003	0.0003	ug/L
PCB052	EPA 1668	0.000003	0.0001	ug/L
PCB066	EPA 1668	0.000003	0.0001	ug/L
PCB101	EPA 1668	0.000005	0.0003	ug/L
PCB105	EPA 1668	0.000004	0.0001	ug/L
PCB118	EPA 1668	0.000004	0.0001	ug/L
PCB128	EPA 1668	0.000005	0.0002	ug/L
PCB138	EPA 1668	0.000005	0.0003	ug/L
PCB153	EPA 1668	0.000004	0.0002	ug/L
PCB170	EPA 1668	0.000004	0.0001	ug/L
PCB180	EPA 1668	0.000003	0.0002	ug/L
PCB187	EPA 1668	0.000006	0.0001	ug/L
PCB195	EPA 1668	0.000003	0.0001	ug/L
PCB206	EPA 1668	0.000003	0.0001	ug/L
PCB209	EPA 1668	0.000004	0.0001	ug/L

Footnotes:

1 - Reporting limits (RLs) and Method Detection Limits (MDLs) listed above are those provided by Eurofins Laboratory for the water column analysis required under the Harbor Toxics TMDL Monitoring Program.

2 - Water column temperature, dissolved oxygen, pH, electrical conductivity and receiving water flow shall be measured in the field with the appropriate calibrated instrument

3 - Select PCB MDLs and RLs are provided, however, total PCBs shall be defined as the sum of all 209 PCB congeners

Appendix B: Analytical Methods, Reporting Limits and Method Detection Levels[1]

Parameter	Analytical Method	Method Detection Levels	Reporting Limit	Units
SEDIMENT ANALYSIS				
Total Organic Carbon	EPA 9060A	170	500	mg/kg
Percent Fines	ASTM D4464	0.01	0.1	0-25
Metals				
Cadmium	EPA 6020	0.0572	0.1	mg/kg
Copper	EPA 6020	0.0419	0.1	mg/kg
Lead	EPA 6020	0.0659	0.1	mg/kg
Mercury	EPA 7471A	0.00587	0.02	mg/kg
Zinc	EPA 6020	0.7950	1.00	mg/kg
PAHs				
Acenaphthene	EPA 8270C SIM PAHs	2.4	10	ug/kg
Anthracene	EPA 8270C SIM PAHs	3.5	10	ug/kg
Biphenyl	EPA 8270C SIM PAHs	1.9	10	ug/kg
Naphthalene	EPA 8270C SIM PAHs	3.5	10	ug/kg
2,6-dimethylnaphthalene	EPA 8270C SIM PAHs	1.7	10	ug/kg
Fluorene	EPA 8270C SIM PAHs	3.1	10	ug/kg
1-methylnaphthalene	EPA 8270C SIM PAHs	2.3	10	ug/kg
2-methylnaphthalene	EPA 8270C SIM PAHs	2.3	10	ug/kg
1-methylphenanthrene	EPA 8270C SIM PAHs	2.5	10	ug/kg
Phenanthrene	EPA 8270C SIM PAHs	2.2	10	ug/kg
Benzo(a)anthracene	EPA 8270C SIM PAHs	2.2	10	ug/kg
Benzo(a)pyrene	EPA 8270C SIM PAHs	1.8	10	ug/kg
Benzo(e)pyrene	EPA 8270C SIM PAHs	2.0	10	ug/kg
Chrysene	EPA 8270C SIM PAHs	2.2	10	ug/kg
Dibenz(a,h)anthracene	EPA 8270C SIM PAHs	2.0	10	ug/kg
Fluoranthene	EPA 8270C SIM PAHs	1.8	10	ug/kg
Perylene	EPA 8270C SIM PAHs	2.4	10	ug/kg
Pyrene	EPA 8270C SIM PAHs	2.2	10	ug/kg
Pesticides[2]				
Alpha Chlordane	EPA 1699	0.00959	0.04	ug/kg
Gamma Chlordane	EPA 1699	0.0114	0.04	ug/kg
Trans Nonachlor	EPA 8081A	0.27	1.0	ug/kg
Dieldrin	EPA 1699	0.0105	0.04	ug/kg
o,p'-DDE	EPA 8270C PEST-SIM	0.035	0.2	ug/kg
o,p'-DDD	EPA 8270C PEST-SIM	0.076	0.2	ug/kg
o'p-DDT	EPA 8270C PEST-SIM	0.062	0.2	ug/kg
p,p'-DDD	EPA 8270C PEST-SIM	0.04	0.2	ug/kg
p,p'-DDE	EPA 8270C PEST-SIM	0.04	0.2	ug/kg
p,p'-DDT	EPA 8270C PEST-SIM	0.053	0.2	ug/kg
PCBs				
PCB008	EPA 8270C SIM PCB Congeners	0.077	0.4	ug/kg
PCB018	EPA 8270C SIM PCB Congeners	0.065	0.2	ug/kg

Parameter	Analytical Method	Method Detection Levels	Reporting Limit	Units
PCB028	EPA 8270C SIM PCB Congeners	0.069	0.2	ug/kg
PCB044	EPA 8270C SIM PCB Congeners	0.15	0.2	ug/kg
PCB052	EPA 8270C SIM PCB Congeners	0.19	0.2	ug/kg
PCB066	EPA 8270C SIM PCB Congeners	0.12	0.2	ug/kg
PCB101	EPA 8270C SIM PCB Congeners	0.044	0.2	ug/kg
PCB105	EPA 8270C SIM PCB Congeners	0.053	0.2	ug/kg
PCB118	EPA 8270C SIM PCB Congeners	0.035	0.2	ug/kg
PCB128	EPA 8270C SIM PCB Congeners	0.12	0.2	ug/kg
PCB 138	EPA 8270C SIM PCB Congeners	0.35	0.4	ug/kg
PCB 153	EPA 8270C SIM PCB Congeners	0.35	0.4	ug/kg
PCB170	EPA 8270C SIM PCB Congeners	0.11	0.2	ug/kg
PCB180	EPA 8270C SIM PCB Congeners	0.092	0.2	ug/kg
PCB187	EPA 8270C SIM PCB Congeners	0.1	0.2	ug/kg
PCB195	EPA 8270C SIM PCB Congeners	0.06	0.2	ug/kg
PCB206	EPA 8270C SIM PCB Congeners	0.12	0.2	ug/kg
PCB209	EPA 8270C SIM PCB Congeners	0.061	0.2	ug/kg

Sediment Toxicity & Benthic Community Effects

Sediment Toxicity analysis shall be performed per the SQO-Part 1 guidelines using percent of control survival as metric. Refer to Table 4, Sediment Toxicity Categorization Values, detailed in the SQO-Part 1 document.

The Benthic Community Condition shall be assessed through the use of 4 benthic indices to determine the benthic index categorization value and associated disturbance. Refer to Table 5, Benthic Index Categorization Values, of the SQO Part-1 document.

Footnotes:

1 - Reporting Limits (RLs) and Method Detection Levels (MDLs) provided are those provided by Eurofins Laboratory for the analyses chosen for the chemical analytes as required in Attachment A of the SQO - Part 1

2 - The MDLs and RLs for chlordane and dieldrin are subject to change depending on the conclusion of the MDL/RL studies being conducted by Eurofins' subcontract laboratory.

Appendix B: Analytical Methods, Reporting Limits and Method Detection Levels[1]

Parameter	Analytical Method	Method Detection Levels	Reporting Limit	Units
FISH TISSUE ANALYSIS				
Chlordane	EPA 8081A	5.30	10.0	ug/kg
Dieldrin	EPA 8081A	0.44	1.0	ug/kg
Toxaphene[2]	EPA 8081A	6.30	20.0	ug/kg
DDT				
o'p-DDT	EPA 8081A	0.31	1.0	ug/kg
p,p'-DDT	EPA 8081A	0.44	1.0	ug/kg
PCBs[3]				
PCB008	EPA 8270C SIM PCB Congeners	0.14	0.40	ug/kg
PCB018	EPA 8270C SIM PCB Congeners	0.071	0.20	ug/kg
PCB028	EPA 8270C SIM PCB Congeners	0.034	0.20	ug/kg
PCB044	EPA 8270C SIM PCB Congeners	0.087	0.20	ug/kg
PCB052	EPA 8270C SIM PCB Congeners	0.063	0.20	ug/kg
PCB066	EPA 8270C SIM PCB Congeners	0.10	0.20	ug/kg
PCB101	EPA 8270C SIM PCB Congeners	0.098	0.20	ug/kg
PCB105	EPA 8270C SIM PCB Congeners	0.055	0.20	ug/kg
PCB118	EPA 8270C SIM PCB Congeners	0.084	0.20	ug/kg
PCB128	EPA 8270C SIM PCB Congeners	0.10	0.20	ug/kg
PCB 138	EPA 8270C SIM PCB Congeners	0.094	0.40	ug/kg
PCB 153	EPA 8270C SIM PCB Congeners	0.17	0.40	ug/kg
PCB170	EPA 8270C SIM PCB Congeners	0.063	0.20	ug/kg
PCB180	EPA 8270C SIM PCB Congeners	0.042	0.20	ug/kg
PCB187	EPA 8270C SIM PCB Congeners	0.084	0.20	ug/kg
PCB195	EPA 8270C SIM PCB Congeners	0.12	0.20	ug/kg
PCB206	EPA 8270C SIM PCB Congeners	0.19	0.20	ug/kg
PCB209	EPA 8270C SIM PCB Congeners	0.15	0.20	ug/kg

Footnotes

1 - Reporting Limits (RLs) and Method Detection Levels (MDLs) provided are those provided by Eurofins Laboratory for the fish tissue analysis required under the Harbor Toxics TMDL Monitoring Program

2 - The MDL and RL provided for toxaphene are those proivded by Eurofins Laboratory. The MDL and RL for toxaphene is subject to change to a lower MDL and RL for comparability with applicable targets depending on the conclusion of the MDL/RL studies being conducted by Eurofins' subcontract laboratory.

3 - Select PCB MDLs and RLs are provided, however, total PCBs shall be defined as the sum of all 209 PCB congeners

APPENDIX C:

HARBOR TOXICS TMDL TARGETS

Appendix C: Harbor Toxics TMDL Targets[1,2]

Water Column Targets	
Parameter	**Waste Load Allocation (ug/L)**
Metals	
Copper	3.73
Lead	8.52
Zinc	85.6
Organics	
PAHs	0.049
Chlordane	0.00059
4'4 DDT	0.00059
Dieldrin	0.00014
Total PCBs	0.00017

Sediment Targets	
Parameter	**Marine Sediment (mg/kg)**
Metals	
Cadmium	1.2
Copper	34
Lead	46.7
Mercury	0.15
Zinc	150
Organics	
Parameter	**Marine Sediment (ug/kg)**
Chlordane, total	0.5
Dieldrin	0.02
Toxaphene	0.1
Total PCBs	22.7
Benzo[a]anthracene	261
Benzo[a]pyrene	430
Chrysene	384
Pyrene	665
2-methlnapththalene	201
Dibenz[a,h] anthracene	260
Phenanthrene	240
Hi MW PAHs	1700
Lo MW PAHs	552
Total PAHs	4022
Total DDT	1.58

Fish Tissue Targets	
Parameter	**Fish Tissue Target (ug/kg)**
Organics	
Chlordane	5.6
Dieldrin	0.46
Total DDT	21
Total PCBs	3.6
Total PAHs	5.47
Toxaphene	6.1

1 – Water targets were determined by the Basin Plan and the California Toxics Rule (CTR) and are included in Attachment A to Resolution No. R11-008.

2 –TMDL targets for the Dominguez Channel Estuary are applicable during both dry and wet weather.

APPENDIX D:

CHAIN OF CUSTODY

Los Angeles Refinery, Wilmington Chain Of Custody Record

Eurofins Laboratory
7440 Lincoln Way
Garden Grove, CA 92841
Tel: (714) 895-5494

Representative to be invoiced:
Los Angeles Refinery - Wilmington Operations
Attn: Robert Nguyen
23208 S. Alameda Street
Carson, CA 90745

COC - WATER COLUMN

Harbor Toxics TMDL Monitoring Program

DATE: ____________________

PAGE: ____1____ of ___1____

CONSULTANT COMPANY: **Los Angeles Refinery Wilmington**

ADDRESS: **2101 E. Pacific Coast Highway**

CITY: **Wilmington, CA 90744**

TELEPHONE:	FAX:	E-MAIL:
310-847-5645	**310-847-5782**	Robert.T.Nguyen@andeavor.com

SITE ADDRESS (Street and City):
Los Angeles Refinery Wilmington
2101 E. Pacific Coast Highway

Individual NPDES Permit No. CA0003778
Order No. R4-2017-0095

PROJECT CONTACT (Report to): **Robert Nguyen (310)847-5645**

CONSULTANT PROJECT NO.:

SAMPLER NAME(S) (Print):

LAB USE ONLY

TURNAROUND TIME (BUSINESS DAYS):
☐ 10 DAYS ☑ 5 DAYS ☐ 72 HOURS ☐ 48 HOURS ☐ 24 HOURS ☐ LESS THAN 24 HOURS

A10:G16
☑ NPDES PERMIT FORMAT

SPECIAL INSTRUCTIONS OR NOTES: TEMPERATURE ON RECEIPT C°

Report all methods to MDLs / Multiple dilutions for low RLs
EPA 8270- Use 2L for extraction (report DF=0.5x)
EPA 8081- low level ML (use Marine RLs)

REQUESTED ANALYSIS

LAB USE ONLY	**Field Sample Identification**	**SAMPLING DATE**	**TIME**	**MATRIX**	**NO. OF CONT.**	**Metals - Copper, Lead and Zinc**	**DDT**	**PCBs**	**PAHs: Benzo(a)anthracene, benzo(a)pyrene, chrysene, phenanthrene, and pyrene**	
	Monitoring Station 01			Aq.		X	X	X	X	**Time Samples Placed on Ice**
	Monitoring Station 03			Aq.		X	X	X	X	**Time Samples Placed on Ice**

FIELD MEASUREMENTS AND EQUIPMENT CLEANING VERIFICATION RECORDED IN SEPARATE FIELD COLLECTION DATA SHEET;

SAMPLE PRESERVATION: SEE QAPP APPENDIX A FOR SAMPLE CONTAINERS, FORM OF PRESERVATION, AND HOLDING TIMES. IF SAMPLES ARE PRESERVED IN A DIFFERENT MANNER, RECORD IN FIELD

NOTE: ALL QA/QC ITEMS MUST BE RUN ON THE SAME DATES THE SAMPLES WERE ACTUALLY ANALYZED.

REPORT ALL APPLICABLE MDLs AND RLs FOR ALL ANALYZED PARAMETERS

E-mail Results to
Robert Nguyen: Robert.T.Nguyen@andeavor.com
Chelsea Dreyer, WGR: cdreyer@wgr-sw.com

Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:

LAST REVISED: 8/9/18

Los Angeles Refinery, Wilmington Chain Of Custody Record

Eurofins Laboratory
7440 Lincoln Way
Garden Grove, CA 92841
Tel: (714) 895-5494

Representative to be invoiced:
Los Angeles Refinery - Wilmington Operations
Attn: Robert Nguyen
23208 S. Alameda Street
Carson, CA 90745

COC - WATER COLUMN TSS

Harbor Toxics TMDL

DATE: ____________________

PAGE: ____1____ of ___1____

CONSULTANT COMPANY: **Los Angeles Refinery Wilmington**

ADDRESS: **2101 E. Pacific Coast Highway**

CITY: **Wilmington, CA 90744**

TELEPHONE: **310-847-5645**

FAX: **310-847-5782**

E-MAIL: Robert.T.Nguyen@andeavor.com

SITE ADDRESS (Street and City): **Los Angeles Refinery Wilmington**
2101 E. Pacific Coast Highway

Individual NPDES Permit No. CA0003778
Order No. R4-2017-0095

PROJECT CONTACT (Report to): **Robert Nguyen (310)847-5645**

CONSULTANT PROJECT NO.:

SAMPLER NAME(S) (Print):

LAB USE ONLY

TURNAROUND TIME (BUSINESS DAYS):
☐ 10 DAYS ☑ 5 DAYS ☐ 72 HOURS ☐ 48 HOURS ☐ 24 HOURS ☐ LESS THAN 24 HOURS

A10:G16
☑ NPDES PERMIT FORMAT

SPECIAL INSTRUCTIONS OR NOTES:

TEMPERATURE ON RECEIPT C°

Report all methods to MDLs / Multiple dilutions for low RLs
EPA 8270- Use 2L for extraction (report DF=0.5x)
EPA 8081- low level ML (use Marine RLs)

REQUESTED ANALYSIS

LAB USE ONLY	**Field Sample Identification**	**SAMPLING DATE**	**SAMPLING TIME**	MATRIX	NO. OF CONT.	Metals - Copper, Lead and Zinc	DDT	PCBs	PAHs: Benzo(a)anthracene, benzo(a)pyrene, chrysene, phenanthrene, and pyrene	FIELD MEASUREMENTS AND EQUIPMENT CLEANING VERIFICATION RECORDED IN SEPARATE FIELD COLLECTION DATA SHEET; SEE QAPP APPENDIX A FOR SAMPLE CONTAINERS, FORM OF PRESERVATION, AND HOLDING TIMES. IF SAMPLES ARE PRESERVED IN A DIFFERENT MANNER, RECORD IN FIELD COLLECTION DATA SHEET.
	Monitoring Station 01			Aq.		X	X	X	X	**Time Samples Placed on Ice**
	Monitoring Station 03			Aq.		X	X	X	X	**Time Samples Placed on Ice**

E-mail Results to
Robert Nguyen: Robert.T.Nguyen@andeavor.com
Chelsea Dreyer, WGR: cdreyer@wgr-sw.com

NOTE: ALL QA/QC ITEMS MUST BE RUN ON THE SAME DATES THE SAMPLES WERE ACTUALLY ANALYZED.

REPORT ALL APPLICABLE MDLs AND RLs FOR ALL ANALYZED PARAMETERS

Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:

LAST REVISED: 8/9/18

Los Angeles Refinery, Wilmington Chain Of Custody Record

Eurofins Laboratory
7440 Lincoln Way
Garden Grove, CA 92841
Tel: (714) 895-5494

Representative to be invoiced:
Los Angeles Refinery - Wilmington Operations
Attn: Robert Nguyen
23208 S. Alameda Street
Carson, CA 90745

COC - Sediment

Harbor Toxics TMDL

DATE: ____________________

PAGE: ____1____ of ___2____

CONSULTANT COMPANY: **Los Angeles Refinery Wilmington**

ADDRESS: **2101 E. Pacific Coast Highway**

CITY: **Wilmington, CA 90744**

TELEPHONE:	FAX:	E-MAIL:
310-847-5645	**310-847-5782**	Robert.T.Nguyen@andeavor.com

SITE ADDRESS (Street and City):
Los Angeles Refinery Wilmington
2101 E. Pacific Coast Highway

Individual NPDES Permit No. CA0003778
Order No. R4-2017-0095

PROJECT CONTACT (Report to): **Robert Nguyen (310)847-5645**

CONSULTANT PROJECT NO.:

SAMPLER NAME(S) (Print):

LAB USE ONLY

TURNAROUND TIME (BUSINESS DAYS):
☐ 10 DAYS ☑ 5 DAYS ☐ 72 HOURS ☐ 48 HOURS ☐ 24 HOURS ☐ LESS THAN 24 HOURS

☑ NPDES PERMIT FORMAT

SPECIAL INSTRUCTIONS OR NOTES:

TEMPERATURE ON RECEIPT C°

Report all methods to MDLs / Multiple dilutions for low RLs
EPA 8270- Use 2L for extraction (report DF=0.5x)
EPA 8081- low level ML (use Marine RLs)

REQUESTED ANALYSIS

LAB USE ONLY	**Field Sample Identification**	**SAMPLING DATE**	**SAMPLING TIME**	**MATRIX**	**NO. OF CONT.**	**Total Organic Carbon**	**Metals***	**PAHs***	**Pesticides***	**PCBs***	**Benthic Community Effect**	**Sediment Toxicity**	
	Monitoring Station 03			Sediment		X	X	X	X	X	X	X	**Time Samples Placed on Ice**

FIELD MEASUREMENTS AND EQUIPMENT CLEANING VERIFICATION RECORDED IN SEPARATE FIELD COLLECTION DATA SHEET;

SEE QAPP APPENDIX A FOR SAMPLE CONTAINERS, FORM OF PRESERVATION, AND HOLDING TIMES. IF SAMPLES ARE PRESERVED IN A DIFFERENT MANNER, RECORD IN FIELD COLLECTION DATA

E-mail Results to
Robert Nguyen: Robert.T.Nguyen@andeavor.com
Chelsea Dreyer, WGR: cdreyer@wgr-sw.com

NOTE:
*** - CONSTITUENTS REQUIRED LISTED IN ATTACHMENT A OF SQO PART 1 (PAGE 2 OF COC)**

ALL QA/QC ITEMS MUST BE RUN ON THE SAME DATES THE SAMPLES WERE ACTUALLY ANALYZED.

REPORT ALL APPLICABLE MDLs AND RLs FOR ALL ANALYZED PARAMETERS

Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:

LAST REVISED: 8/1/18

Los Angeles Refinery, Wilmington Chain Of Custody Record

Eurofins Laboratory
7440 Lincoln Way
Garden Grove, CA 92841
Tel: (714) 895-5494

Representative to be invoiced:
Los Angeles Refinery - Wilmington Operations
Attn: Robert Nguyen
23208 S. Alameda Street
Carson, CA 90745

COC - Fish Tissue

Harbor Toxics TMDL
Monitoring Program

DATE: ____________________

PAGE: ____1____ of ___1____

CONSULTANT COMPANY: **Los Angeles Refinery Wilmington**

ADDRESS: **2101 E. Pacific Coast Highway**

CITY: **Wilmington, CA 90744**

TELEPHONE: **310-847-5645**

FAX: **310-847-5782**

E-MAIL: Robert.T.Nguyen@andeavor.com

SITE ADDRESS (Street and City): **Los Angeles Refinery Wilmington**
2101 E. Pacific Coast Highway

Individual NPDES Permit No. CA0003778
Order No. R4-2017-0095

PROJECT CONTACT (Report to): **Robert Nguyen (310)847-5645**

CONSULTANT PROJECT NO.:

SAMPLER NAME(S) (Print):

LAB USE ONLY

TURNAROUND TIME (BUSINESS DAYS):
☐ 10 DAYS ☑ 5 DAYS ☐ 72 HOURS ☐ 48 HOURS ☐ 24 HOURS ☐ LESS THAN 24 HOURS

☑ NPDES PERMIT FORMAT ______________________

SPECIAL INSTRUCTIONS OR NOTES: TEMPERATURE ON RECEIPT C°

Report all methods to MDLs / Multiple dilutions for low RLs
EPA 8270- Use 2L for extraction (report DF=0.5x)
EPA 8081- low level ML (use Marine RLs)

REQUESTED ANALYSIS

LAB USE ONLY	**Field Sample Identification**	**SAMPLING DATE**	**SAMPLING TIME**	**MATRIX**	**NO. OF CONT.**	**Chlordane**	**Dieldrin**	**Toxaphene**	**DDT**	**PCBs**															
	Monitoring Station 04			Tissue		X	X	X	X	X															

E-mail Results to
Robert Nguyen: Robert.T.Nguyen@andeavor.com
Chelsea Dreyer, WGR: cdreyer@wgr-sw.com

NOTES:
ALL QA/QC ITEMS MUST BE RUN ON THE SAME DATES THE SAMPLES WERE ACTUALLY ANALYZED.

REPORT ALL APPLICABLE MDLs AND RLs FOR ALL ANALYZED PARAMETERS

FIELD MEASUREMENTS AND EQUIPMENT CLEANING VERIFICATION RECORDED IN SEPARATE FIELD COLLECTION DATA SHEET;

SEE QAPP APPENDIX A FOR SAMPLE CONTAINERS, FORM OF PRESERVATION, AND HOLDING TIMES. IF SAMPLES ARE PRESERVED IN A DIFFERENT MANNER, RECORD IN FIELD COLLECTION DATA SHEET.

Time Sample Placed on Ice

SAMPLE LOCATION / COORDINATES:

____

Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:

LAST REVISED 5/14/18

APPENDIX E:

FIELD MONITORING FORMS

HARBOR TOXICS TMDL FIELD COLLECTION DATA SHEET

StationID:	**Date (mm/dd/yyyy):**	**SampleTime (1st sample):**	**Sampled By:**

Station Location:	**Arrival Time:**	**Departure Time:**	**Form of preservation:** ice other : ______________________

Purpose (circle applicable): Water Chemistry / TSS Sediment Fish Tissue

Time placed on ice / preserved:

Location:	**GPS/DGPS**	**Lat (dd.ddddd)**	**Long (ddd.ddddd)**
GPS Device:	**Target:**		-
Accuracy (ft / m):	**Actual:**		-

Additional Sample Preservation Notes:

FIELD OBSERVATIONS (CIRCLE ALL THAT APPLIES)

WATER ODOR	None Sewage Petroleum Sulfides Mixed Other_______	**WIND DIRECTION:**	
SKY COVER:	Clear Partly Cloudy Overcast Fog Smoky Hazy Other:____________	**PRECIPITATION:**	None Fog Drizzle Rain Snow
OTHER PRESENCE:	Floating and Suspended Materials Oily Sheen Turbidity Odor Foam Trash Discoloration Other_____________________________	**Precipitation Amount:** **(last 24 hours)**	inches
		WATER CLARITY:	Clear Cloudy Murky
WATERCOLOR:	Colorless Green Yellow Brown Other: ________________________		

FIELD MEASUREMENTS:

Type of Sample:	Sample Type	Flow	Water Temp (°F)	pH (S.U.)	Dissolved Oxygen (mg/L or %)	Salinity (ppt)	Depth (m)	Equipment Decontaminated:
Water Column Samples								☐ Yes
TSS Samples								☐ Yes
Sediment Samples								☐ Yes

CALIBRATION INFORMATION:

Instrument Type:	Flow	Temp.	pH	Dissolved Oxygen	Salinity	Notes:
Instrument:						
Calibration Date:						
Calibration Standards						
Calibration Readings						

FIELD STAFF CONFIRMATION OF FIELD DATA SHEET

My signature below certifies that I have reviewed the information recorded in this Field Collection Data Sheet and determined it to be complete:

Date / Time Reviewed:	Signature
Name:	
Title:	

APPENDIX F:

SWAMP COLLECTION OF WATER AND BED SEDIMENT WITH ASSOCIATED FIELD MEASUREMENTS AND PHYSICAL HABITAT IN CALIFORNIA

Collections of Water and Bed Sediment Samples with Associated Field Measurements and Physical Habitat in California.Version 1.1 updated March-2014

The SOPs below are for reference and information purposes only, the documents are recommended, not required by the Surface Water Ambient Monitoring Program (SWAMP). Please see the SWAMP Quality Assurance Program Plan at: http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#qa for more information regarding SWAMP QA/QC requirements.

Table of Contents

Acknowledgements:

This procedure has been modified from the Texas Natural Resources Conservation Commission's Procedure Manual for Surface Water Quality Monitoring, with major input from the United State's Geological Survey's (USGS's) National Water Quality Assessment (NAWQA) Protocol for Collection of Stream Water Samples, for which due credit is here with given.

The current version of these protocols was written by Sean Mundell (Moss Landing Marine Labs MPSL Field Sampling Team) with most of the credit to Max Puckett (CDFW) for originally writing this document for part of the original SWAMP QAMP, 2001. Significant contributions also came from Eric von der Geest and the (SWAMP) Quality Assurance (QA) Team, The SWAMP Data Management Team(DMT), Billy Jakl(MPSL), Mary Hamilton (RWQCB 3), and Bettina Sohst(former MPSL employee),

Field Measurements

Field Data Sheets

Field data sheets are used to record field observations, probe measurements, and water and sediment chemistry sampling. Field data sheets are provided on the SWAMP Data Management Resources Website at: **Water Quality Field Data Sheet** *(updated 12/18/12)*.

There are guidelines provided below to standardize what is recorded on all data sheets and that should be helpful in completing each form. The entries discussed below and on the field data sheets are recorded at each sampling site.

Notes to Standardize SWAMP Field Data Sheets (For in the field use)

KEY REMINDERS to IDENTIFY SAMPLES:

1. **SAMPLE TIME** is the SAME for all samples (Water, Sediment, & Probe) taken at the sampling event. Use time of FIRST sample; important for COC (is used for identification of sample).
2. **LEFT BANK/RIGHT BANK**
   Left bank is defined as the bank to the left of the observer when facing downstream, and the *right bank* is to the right of the observer when facing downstream
3. **GROUP;** many different ways to do a group, one suggestion is to create groups which assign trips to assess frequency of field QA

COLLECTION DETAILS:

1. **PERSONELL**: S. Mundell, G Ichikawa (first person listed is crew leader)
2. **LOCATION:** Bank, Thalweg, Mid-Channel, Open Water**.** Use "open water" in bay/estuary/harbor only if no distinguishable channel exists
3. **GRAB vs. INTEGRATED**: GRAB samples are when bottles are filled from a single depth; INTEGRATED sample are taken from MULTIPLE depths/grabs and combined.
   A. GRAB: use 0.1 for subsurface samples; if too shallow to submerge bottle; depth = 0
   B. INTEGRATED: -88 in depth sampled, record depths combined in sample comments
4. **TARGET LAT/LONG**: Refers to the existing station location that the sampling crew is trying to achieve; can be filled out prior to sampling
5. **ACTUAL LAT/ LONG**: is the location of the current sample event.
6. **HYDROMODIFICATION:** Describe existing hydro modifications such as a grade control, drainage pipes, bridge, culvert
7. **HYDROMOD LOC**: if there is an IMMEDIATE (with in range potentially effecting sample) hydro modification; Is the hydro modification upstream/downstream/within area of sample; if there is no hydro modification, NA is appropriate
8. **STREAM WIDTH and DEPTH**: describe in meters at point of sample.

FIELD OBSERVATIONS: (each one of these observations has a comment field in the database so use comment space on data sheet to add information about an observation if necessary)

1. **PICTURES:** use space to record picture numbers given by camera; be sure to rename accordingly back in the office. (StationCode_yyyy_mm_dd_unique code)
2. **WADEABILITY**: in general, is water body being sampled wadeable to the average person AT the POINT of SAMPLE
3. **DOMINANT SUBSTRATE**: if possible; describe DOMINANT substrate type; use UNK if you cannot see the dominant substrate type
4. **BEAUFORT SCALE**: use scale 0-12; refer to scales listed on page 28
5. **WIND DIRECTION**: records the direction from which the wind is blowing
6. **OTHER PRESENCE**: VASCULAR refers to terrestrial plants or submerged aquatic vegetation

(SAV) and NONVASCULAR refers to plankton, periphyton etc. These definitions apply to vegetation IN the water at the immediate sampling area.

7. **OBSERVED FLOW**: Visual estimates of flow range in cubic feet/second. Flow should be recorded even if flow is visible but not measurable on that sampling visit. This is an observational measurement that is highly dependent on the knowledge of monitoring personnel.
8. **WATER COLOR**: This is the color of the water from standing creek side
9. **WATER CLARITY**: this describes the clarity of the water while standing creek side; clear represents water that is clear to the bottom, cloudy may not be clear to bottom but greater than 4 inches can be seen through the water column.
10. **PRECIPITATION LAST24hrs:** refers to field crew's best categorization of rainfall in the last 24 hrs; may or may not effect Overland Runoff Last 24 hrs
11. **OVERLAND RUNOFF LAST 24 hrs**: Significant precipitation is defined as any amount that visibly influences water quality. Light Precipitation = fog, drizzle, and/or light rain with no overland runoff; Mod to Heavy Precipitation = rain such that site probably or definitely received at least some overland runoff.
12. **SEDIMENT COMP**: generally described sediments used for chemistry sample Note: these reminders do not give all details needed to maintain equivalent SWAMP sampling protocols, they are strictly for "infield" use to help insure comparability of field observations.
13. **WATER APPEARANCE:** Note general appearance (e.g., color, unusual amount of suspended matter, debris or foam)
14. **SEDIMENT APPEARANCE** Color, Odor and sediment composition should be noted.
15. **WEATHER:** Note recent meteorological events that may have impacted water quality; (e.g., heavy rains, cold front, very dry, very wet)
16. **BIOLOGICAL ACTIVITY:** Note excessive macrophyte, phytoplankton or periphyton growth. The observation of water color and excessive algal growth is very important in explaining high chlorophyll a values. Other observations such as presence of fish, birds and spawning fish are noted.
17. **WATERSHED or INSTREAM ACTIVITIES:** Note in stream or drainage basin activities or events that is impacting water quality (e.g., bridge construction, shoreline mowing, livestock watering upstream).
18. **RECORD of PERTINENT OBSERVATIONS RELATED to WATER QUALITY and STREAM USES:** If the water quality conditions are exceptionally poor, note that standards are not met in the observations, (e.g., dissolved oxygen is below minimum criteria). Note uses (e.g., swimming, wading, boating, fishing, irrigation pumps, navigation). Eventually, for setting water quality standards, the level of use will be based on comments related to the level of fishing and swimming activities observed at a station.
19. **SPECIFIC SAMPLE INFORMATION:** Note specific comments about the sample itself that may be useful in interpreting the results of the analysis (e.g., number of sediment grabs, or type and number of fish in a tissue sample). If the sample was collected for a complaint or fish kill, make a note of this in the observation section.
20. **MISSING PARAMETERS:** If a scheduled parameter or group of parameters is not collected, make some note of this in the comments.
21. **RECORD of DATA SUBMISSION:** Initials and date are recorded on the field data sheet showing a record that the data has been transcribed onto data forms and submitted to the SWAMP data management staff.

Record of Samples Collected for Purposes of Chemical Analysis

The general types of chemical samples to be collected are listed for each site, since this may vary from site-to-site (e.g., metals-in-water, pesticides-in-sediments, conventional water quality). Analyses authorization forms are recommended since different authorized laboratories perform different chemical analyses. The method of preservation for each chemical sample is recorded, as appropriate on the Chain of Custody Form (COC).

Field Data Measurements

While collecting water samples (see Field Collection Procedures for Water Samples page 29), record appropriate field measurements. When field measurements are made with a multi-parameter instrument, it is preferable to place the sonde in the body of water to be sampled and allow the dissolved oxygen (D.O.) to equilibrate. D.O. usually takes the longest to equilibrate out of the probe measurements (pH, Temperature, Conductivity and Turbidity) Field measurements are made at the centroid of flow, if the stream visually appears to be completely mixed from shore to shore. *Centroid* is defined as the midpoint of that portion of the stream width which contains 50% of the total flow. Probe measurements and water sampling are best to collect in the stream location that best represents the entire stream. For routine field measurements, the date, time and depth are reported as a grab. Quality control requirements for field measurements are listed in Quality Control and Sample Handling Tables for Field Measurements in Fresh and Marine Water.

Recommended Depths for Conducting Field Data Measurements

Water Depth Less than 5 ft (<1.5 m)	If the water depth is less than 5 ft (1.5 m), grab samples for water are taken at approximately 0.1 m (4 in.), and multi-probe measurements are taken at approximately 0.2 m (8 in.). This is because all sensors have to be submerged, so 0.1 m would not be deep enough. But taking a grab sample at 0.2 m is not always feasible, as it is difficult to submerge bottles to that depth, and in many cases the bottle will hit the stream bottom.
Water Depth Greater than 5 ft (>1.5 m)	If the water depth at the sampling point exceeds 5 ft (1.5 m) in depth, a vertical profile of dissolved oxygen, temperature, pH and specific conductance are made using the multi-parameter probe equipment. The depth of the sonde at the time of measurement is most accurately determined from the depth sensor on the multi-parameter sonde rather than depth labels on the cable.
Vertical Depth Profiles and Depth-Integrated Sample Collection	If depth integration sampling is being conducted, or if vertical profile measurements are requested, multi-probe measurements are made starting at a depth of 0.2 m, and are then conducted at 1.0, 2.0, 3.0, 4.0, and 5.0 m depths after that until 5.0 m depth is reached. Beginning at 5.0 m, measurements are made every 5.0 m through depth profile.

Field data for multi-parameter vertical depth profiles are recorded in final form on the SWAMP Field Data Sheets and submitted to the SWAMP data management staff. Go to http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#qa for detailed information on data reporting.

Water Temperature (^{O}C)

Water temperature data are recorded for each site visit in final form on a Field Data Sheet and submitted to the SWAMP data management staff.

Temperature Sampling Procedures

Temperature is measured in-stream at the depth(s) specified above. Measuring temperature directly from the stream by immersing a multi-probe instrument or thermometer is preferred.

Hand Held Centigrade Thermometer

If an electronic meter is not available, the temperature is measured with a hand-held, centigrade thermometer (Rawson, 1982).

- In wadeable streams, stand so that a shadow is cast upon the site for temperature measurement.
- Hold the thermometer by its top and immerse it in the water. Position the thermometer so that the scale can be read.
- Allow the thermometer to stabilize for at least one minute, then without removing the thermometer from the water, read the temperature to the nearest 0.1^{o} C and record.
- Do not read temperature with the thermometer out of the water. Temperature readings made with modern digital instruments are accurate to within ± 0.1^{o} C.

Temperature Measurement from a Bucket

When temperature cannot be measured in-stream, it can be measured in a bucket-Nalgene or plastic container. Care must be taken to insure a measurement representative of in-stream conditions.

The following conditions must be met when measuring temperature from a bucket:

- The bucket must be large enough to allow full immersion of the probe or thermometer.
- The bucket must be brought to the same temperature as the water before it is filled.
- The probe must be placed in the bucket immediately, before the temperature changes.
- The bucket must be shaded from direct sunlight and strong breezes prior to and during temperature measurement.
- The probe is allowed to equilibrate for at least one minute before temperature is recorded.
- After these measurements are made, this water is discarded and another sample is drawn for water samples which are sent to the laboratory.

pH (standard units)

pH data is recorded for each SWAMP visit in final form on the Field Data Sheets and submitted to the SWAMP data management staff. Go to http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#qa for detailed information on data reporting.

pH Sampling Equipment

The pH meter should be calibrated according to the recommended procedures for calibration and maintenance of SWAMP field equipment. Calibration directions are listed in the manufactures field equipment operations manual. The pH function is pre and post calibrated every 24 h of use for multi-parameter instruments.

pH Sampling Procedures

In-stream Method

Preferably, pH is measured directly in-stream at the depth(s) specified earlier in this document. Allow the pH probe to equilibrate for at least one minute before pH is recorded to the nearest 0.1 pH unit.

pH Measurement from a Bucket

When pH cannot be measured in-stream, it can be measured in a bucket-Nalgene or plastic container. The following precautions are outlined above; “Temperature Measurement from a Bucket”.

Potential Problems

- If the pH meter value does not stabilize in several minutes, out gassing of carbon dioxide or hydrogen sulfide, or the settling of charged clay particles may be occurring (Rawson, 1982).
- If out gassing is suspected as the cause of meter drift, collect a fresh sample, immerse the pH probe and read pH at one minute.
- If suspended clay particles are the suspected cause of meter drift, allow the sample to settle for 10 min, then read the pH in the upper layer of sample without agitating the sample.
- With care, pH measurements can be accurately measured to the nearest 0.1 pH unit.

Dissolved Oxygen (mg/L)

Dissolved oxygen (D.O.) data is recorded for each SWAMP visit in final form on a Field Data Sheet and submitted to the SWAMP data management staff.
See http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#qa for detailed information on data reporting.

Dissolved Oxygen Sampling Equipment

The dissolved oxygen meter should be calibrated according to the recommended procedures for calibration and maintenance of SWAMP field equipment. Calibration directions are listed in the manufactures field equipment operations manual.

Multi-probe Instrument

Pre and post calibrate the D.O. sensor every 24 h and for elevations greater than 500 ft on the multi-probe instrument. Preferably, D.O. is measured directly in-stream at the depth(s) specified in the Field Measurements section above. The D.O. probe must equilibrate for at least 90 s before D.O. is recorded to the nearest 0.1 % saturation or mg/L. Care must be taken at profile stations to insure that the reading is stable for each depth. Since dissolved oxygen takes the longest to stabilize, record this parameter after temperature, conductivity and pH. If the D.O. probe has an operable, automatic stirrer attached, the D.O. probe does not have to be manually stirred. However, if the probe is not equipped with an automatic stirrer, manual stirring must be provided by raising and lowering the probe at a rate of 1 ft/s (0.3m/s) without agitating the water surface. If the stream velocity at the sampling point exceeds 1 ft/s, the probe membrane can be pointed upstream into the flow and manual stirring can be avoided (Rawson, 1982).

D.O. Measurement from a Bucket

When D.O. cannot be measured in-stream, it can be measured in a bucket-Nalgene or plastic container, following precautions outlined in the Temperature Measurement from a Bucket listed above. During equilibration and reading, water should be moved past the membrane surface at a velocity of 1 ft/s (0.3 m/sec), either by automatic stirrer or manual stirring. If stirred manually in a bucket, the water surface is not agitated (Rawson, 1982).

24-Hour Average D.O. Continuous Monitoring (if requested in special study)

Unattended 24-Hour D.O. Data Collection

Why Collect 24-Hour Data

Dissolved oxygen sampling for standards compliance is targeted to water bodies where low instantaneous D.O. levels indicate partial or nonsupport of designated aquatic life uses. Intensive monitoring is conducted with automated equipment that is preset to record and store field measurements hourly over one 24-h period. Four or more dissolved oxygen measurements may also be made manually at 4-6-h intervals over one 24-h period, as long as one is made near sunrise (0500-0900 h) to approximate the daily minimum. However, data collected with automated equipment is preferred.

When to Take Measurements

All 24-h D.O. monitoring events must be spaced over an index period representing warm-weather seasons of the year (approx March 15-October 15), with between one-half to two-thirds of the measurements occurring during the critical period (July 1-September 30). The ***critical period*** of the year is when minimum stream flows, maximum temperatures, and minimum dissolved oxygen concentrations typically occur in area streams. **A flow measurement must be taken at the time of deployment.** In a perennial stream, a 24-h data for standards compliance can not be used if the flow is less than the 7Q2. In perennial streams, the D.O. criterion to do not apply for flows under the 7Q2. A period of about one month must separate each 24-h sampling event. Additional samples may be collected outside the index period to further characterize a water body, but that information is generally not used for assessing standards compliance.

Frequency of Measurements

The measurement interval should be no more than once per 15 min and no less than once per hour.

Where to Take Measurements

For purposes of determining standards compliance with the 24-h average criteria, samples collected near the surface will be considered representative of the mixed surface layer. In deep streams, reservoirs, and tidally influenced water bodies, automated equipment is positioned between 1 foot (from the surface) to one-half the depth of the mixed surface layer. At least 10 24-h monitoring events (using the 24-h criteria and/or absolute minimum criteria) at each site within a 5-year period are recommended to provide adequate data for assessment.

When to Collect Other Routine Samples, if doing 24-hour D.O. measurements

Other routine field measurements and water samples should be collect at either the time of deployment, at the reference check, or when the multi-probe recording 24-h data is retrieved. When ever possible, flow must be measured at the 24-h site.

Priority for Scheduling 24-Hour Sampling Events

- 303d listed waterbodies
- Waterbodies with Concerns for DO problems (too few samples available for full use assessment).
- Occurrence of low D.O. concentrations observed during the day
- Waterbodies with trends indicating declining D.O. concentrations
- Waterbodies which would contribute to an Eco-region data set

Data Reporting for 24-hour D.O. measurements

Dissolved oxygen values recorded over the 24-h period are summed and divided by the number of measurements to determine the average concentration, which is compared to the 24-h criterion. The lowest D.O. value from each 24-h set is compared to the minimum criterion. There will be occasions when a complete 24-h data set won’t be possible. For example, if there are 18 measurements instead of 24, a time weighted diurnal average needs to be calculated. This can be easily done using GW Basic.

Support of assigned aquatic life use is based on 24-h D.O. average and minimum criteria for each monitoring event. Report the 24-h average D.O. value, number of measurements over a 24-h period, and the minimum, and maximum values. Report data as a time composite sample with a beginning and ending date and time, covering the 24-h period measured.

Specific Conductance (µS/cm)

Specific conductance should be recorded for each SWAMP visit in final form on a Field Data Sheet and submitted to the SWAMP data management staff.
See http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#qa for detailed information on data reporting.

Specific Conductance Sampling Equipment

The conductivity meter should be calibrated according to the recommended procedures for calibration and maintenance of SWAMP field equipment. Calibration directions are listed in the manufactures field equipment operations manual.

Specific Conductance Sampling Procedure

Preferably, conductivity is measured directly in-stream at the depth(s) specified earlier in this document. Allow the conductivity probe to equilibrate for at least one minute before specific conductance is recorded to three significant figures (if the value exceeds 100). The primary physical problem in using a specific conductance meter is entrapment of air in the conductivity probe chambers. The presence of air in the probe is indicated by unstable specific conductance values fluctuating up to ±/-100 µS/cm. The entrainment of air can be minimized by slowly, carefully placing the probe into the water; and when the probe is completely submerged, quickly move it through the water to release any air bubbles.

If specific conductance cannot be measured in-stream, it should be measured in the container it can be measured in a bucket-Nalgene or plastic container. The following precautions are outlined above; “Temperature Measurement from a Bucket”.

Salinity (parts per thousand--ppt, or ‰)

The value for salinity is computed from chloride concentration or specific conductance. The calculation assumes a nearly constant ratio for major ions in an estuary when seawater is diluted by river water. This assumption does not hold for cases where salinity is less than about three parts per thousand. Salinity determinations at such low values are only approximate. In estuarine waters, salinity is a relevant and meaningful parameter. Often the salinity may be low, approaching that of freshwater. Nevertheless, this is useful information. Determine if a station is estuarine from historical records (i.e., experiences cases where salinity is >2.0 ppt) and always report salinity at this station, regardless of the salinity during periods of high flow.

Salinity is measured directly in-stream at the depth(s) specified earlier in this document. Salinity data should be recorded for each SWAMP visit in final form on a Field Data Sheet and submitted to the SWAMP data management staff. See http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#qa for detailed information on data reporting.

Values between 2.0 ppt and 1.0 ppt should be reported as <2.0 ppt rather than the actual value and values <1.0 ppt should be reported as <1.0 ppt. The field instruments compute salinity from specific conductance and temperature, and display the value in parts per thousand. Report salinity values above 2.0 ppt to the nearest 0.1 ppt.

Secchi Disc Transparency (meters)--if requested in special study

Secchi disk transparency should be recorded for each SWAMP visit in final form on a Field Data Sheet and submitted to the SWAMP data management staff. See http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#qa for detailed information on data reporting.

Secchi Disk Sampling Equipment

- Secchi disk, 20 cm in diameter
- Measuring tape

Secchi Disk Transparency Sampling Procedures

Preferably, Secchi disk transparency is measured directly in-stream wherever conditions allow. The Secchi disk should be clean, weighted and suspended with chain, wire, or Dacron line (the line used to suspend the Secchi disk should not be nylon or cotton; stretching may cause erroneous readings). Another option is to attach the Secchi disk to a metal rod calibrated in metric units.

Average Turbidity	The Secchi disk should be lowered vertically in a location shielded from direct sunlight. Glare from the water's surface will affect the accuracy of the measurement. Don't wear sunglasses. Slowly lower the disk until it disappears from view. The person viewing the disk should maintain an eye level of less than two meters above the water's surface. Note the depth at which the disk disappears from view. Slowly raise the disk until it becomes visible. Note the depth at which the disk reappears. Compute the mathematical average of the two depths noted and record the average value to two significant figures on the field data sheet. The recorded average value is the Secchi disk transparency.
High Turbidity (Muddy Water)	In streams with very high turbidity, high velocity, and/or poor access, it may be necessary to measure Secchi disk transparency in a bucket. Fill the bucket from the centroid of flow being careful not to disturb the substrate. Follow steps above for measuring the Secchi disk depth within 30 s after raising the filled bucket from the water's surface. Or, re-suspend the solids by stirring, then quickly make the measurement. Record Secchi disk transparency to two significant figures.
Low Turbidity (Clear Water)	Some bodies of water will be so clear and shallow that it will not be possible to lower the Secchi disk until it disappears from view. Measure and record the depth at the deepest point accessible. Report Secchi disk transparency as greater than the deepest depth measured.

Example (Low Turbidity): South Fork Rocky Creek is a small (<1 ft^3/s) clear stream. The stream in the vicinity of the sampling site was less than 1 m deep and the bottom was clearly visible everywhere. However, a pool was located in the stream next to a bridge. The maximum depth of the pool was 2.6 m at which depth the Secchi disk was still visible. Therefore, Secchi disk transparency for South Fork Rocky Creek was recorded as > 2.6 m.

Importance of Secchi Disk Data

Eutrophication, the natural aging process in reservoirs and lakes is accelerated by human activities which add nutrients to lakes, reservoirs, and the surrounding watersheds. Section 314 of the Clean Water Act (CWA) of 1987 requires all states to classify lakes and reservoirs according to trophic state. Although chlorophyll a is the most direct measure of algal biomass, other indices and programs utilize Secchi disk depth as the primary factor.

Turbidity Measurement with Turbidity Meter

Nephelometric Turbidity (turbidity standard unit is called Nephelometric Turbidity Units (NTU)) can be determined by measuring the amount of scatter when light is passed through a sample using a turbidity meter. The LaMotte 2020 Turbidity meter is a suitable instrument for example. There are also turbid-ometers attached to multi-probe instruments like YSI or Hydro-Lab.

Turbidity meters should be calibrated using a standard close to the expected sample value. Calibration standards should be used that are relative to the suspended sediment particles in the sampleable water column. Typical calibration standard values are 1, 10, 100, and 1000 NTU’s.

For instructions on how to operate the instruments refer to the manufacturer’s manual. Turbidity measurements can be executed together with water sampling. The turbidity sample has to be representative for the sampled water mass. Make sure that no gas bubbles are trapped in the vial for the reading and that the outside of the vial is wiped completely clean (i.e., meaning free of moisture, lint and fingerprints). Take several measurements to assure an accurate reading. Do not record values that vary greatly. If variations are small, record an average. If settling particles are present, record a reading before and one after settling. The meter might have to be recalibrated with a different standard, if the sample water readings are outside of the calibration standard limits.

Flow

Sampling crews should be notified on reconnaissance forms if it is known that there is an operational United States Geological Survey (USGS) gage located at or nearby a sampling site. If there is a USGS gage nearby, a gage height in feet is recorded and later converted to an instantaneous flow value and recorded on the field data sheet. The gage height is always to be reported to the USGS for conversion to flow. If a USGS gage is not available, a flow measurement should be taken, if requested. See Instantaneous Flow Measurement information starting on page 13 in this document. Centroid velocity measurements may also be taken as a minimum acceptable rough characterization of the stream flow as requested, although this measurement is not to be recorded as a flow, since it is only a velocity measurement
Flow information for over 200 USGS sites is available on the Internet. The address is **http://water.usgs.gov/index.html**. This is useful information in determining flow conditions prior to sampling. This information may be included in general observations.

Flow Measurement Method (Reporting)

The method used to measure flow is noted by reporting which instrument or gage is used. Examples are, Flow Gage Station (USGS/IBWC), Electric Marsh-McBirney flo mate 4000, Mechanical (ex. Pigmy meter), Weir/Flume, Other (orange peel, etc.) Flow data transformers are used to enter flow data into the SWAMP database. Please contact the SWAMP data management team to obtain the flow data transformer.

Flow (ft^3/s)

If requested, flow data should be recorded for each monitoring visit to non-tidal, flowing streams. Flow data should be recorded in final form on a Field Data Sheet and submitted to the SWAMP data management staff. See http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#qa for detailed information on data reporting. The following are two exceptions to the flow reporting requirement:

No Flow/ Pools	If there is no flow at a stream site and accessible, isolated pools remain in the stream bed, collect and report the required field data and laboratory samples from the pools and report instantaneous flow. Under these conditions, flow (ft^3/s) should be reported as zero. Pools may represent natural low-flow conditions in some streams and the chemistry of these pools will reveal natural background conditions.
Dry	If the stream bed holds no water, the sampling visit is finished. Report that the stream was "dry" in the observations. No value is reported for flow since there is no water.

Flow Measurement

If a flow measurement is required at a site, measure and record flow after recording visual observations. The intent of measuring flow first is to delay collection of chemical and biological water samples with limited holding times. Care must be taken not to collect water samples in the area disturbed during flow measurement. There are several acceptable flow measurement methods that can be used.

U.S. Geological Survey (USGS) Gaging Station

Some SWAMP Stations are sampled at sites where the USGS maintains flow gaging equipment. On any type of sampling visit to a site that has a USGS flow gage, observe and record the gage height to the nearest hundredth of a foot in the field logbook. Upon return to the office, contact the USGS office responsible for maintaining the gage. USGS personnel can provide the flow value in cubic feet per second (ft^3/s) that corresponds to the gage height. Although SWAMP personnel may have a rating curve available to them, shifts associated with changes in the stream bed may occur over time. Always call the USGS to determine the shift. At some sites the shift changes frequently. At others, the relation between stream flow and gage height is almost unchanging. If a gage is no longer maintained by USGS, cross out the recorded gage height and be prepared to measure flow by another method on the return visit to that site.

Several factors may influence the accuracy of the USGS rating curves that are used to convert gage height to flow. If there is any doubt about the accuracy of a USGS gage height reading or flow rating curve, sampling personnel should measure the flow if possible.

Gage height may be indicated at a USGS gage by one of three methods:

Staff Gage	Staff gages are enameled steel plates (with the appearance of large measuring tapes) bolted to some stable structure. For example, staff gages may be bolted to concrete bridge abutments, pillars, or docks. The staff gage face is white with black lettering and gradations. The gradations shown are feet, tenths of a foot, and 0.02 of a foot. The point at which the water level crosses the staff gage should be recorded to the nearest hundredth of a foot.
Wire Weight Gage	Wire weight gages are locked, metal boxes with approximate dimensions of 15 in. long x 12 in. tall x 12 in. deep. Wire weight gages are usually affixed to bridge rails near mid-stream. They must be unlocked with a USGS key. The wire weight gages house a weight attached by wire cable to a graduated reel (gradations are tenths and hundredths of feet) with a counter at one end. When the reel is released the weight can be gradually lowered until the bottom of the weight contacts the water surface. At the point of contact, the weight causes the water surface to ripple slightly. Maintaining the weight in that position, record the counter value to the nearest whole number and the point indicated by the stylus on the graduated reel to the nearest hundredth of a foot. Determine if the gage is the movable type that can be moved to multiple

locations on the bridge. This type is common on braided streams. A correction value is stamped on the bridge near each point that the gage can be attached. Record the corrected value as the gage height in feet.

Bubble Gage Bubble gages are locked in metal sheds that are approximately 4 ft wide x 4 ft deep x 6.5 ft tall. The gage houses are most frequently located on the shore near a bridge but sometimes are attached to bridge pillars near mid-stream or established on the stream bank far from any bridge. The gage house must be unlocked with a USGS key. Bubble gages in gage houses usually indicate the gage height in two or three locations. A counter attached to the manometer system indicates gage height in feet. Some gage houses have stilling wells that can be entered. Often there is a staff gage on the inside wall.

Most bubble gages are also equipped with digital recorders. Digital recorders consist of two white, coded discs, approximately 4 in. in diameter with a punch tape overlapping a portion of each disc. The discs are marked with 100 gradations. As the front of the digital recorder is viewed, the stylus at the disc on the left indicates height in feet. The stylus at the disc on the right indicates gage height in hundredths of feet. The gage height from both discs should be added and the number recorded in the field logbook as gage height to the nearest hundredth of a foot.

Many USGS metal sheds also contain a surface level recorder. This devise can be opened to determine how stable stream flow has been prior to the sampling event. Record observations concerning the flow hydrograph.

Instantaneous Flow Measurement

Water quality monitoring visits to sites where there are no nearby USGS flow gauges will require water quality monitoring personnel to measure flow, when requested by Regional Water Quality Control Boards (Regional Boards).

Flow Measurement Equipment

Flow meter

One of the following or an equivalent:

- Marsh-McBirney Electronic meter
- Montedoro-Whitney Electronic meter
- Price Pigmy meter (with timer and beeper)
- Price meter, Type AA (with Columbus weight)

Additional Equipment

- Top-setting wading rod (preferably measured in tenths of feet)(see Figure 1).
- Tape measure (with gradations every tenth of a foot or every centimeter).

Flow Measurement Procedure (USGS, 1969)

Select a stream reach with the following characteristics:

- Straight reach with laminar flow (threads of velocity parallel to each other) and bank to bank. These conditions are typically found immediately upstream of riffle areas or places where the stream channel is constricted.
- The site should have an even streambed free of large rocks, weeds, and protruding obstructions that create turbulence. The site should not have dead water areas near the banks, and a minimum amount of turbulence or back eddies.

Flat Streambed Profile (cross section)

Stretch the measuring tape across the stream at right angles to the direction of flow. When using an electronic flow meter, the tape does not have to be exactly perpendicular to the bank (direction of flow). When using a propeller or pigmy type meter, however, corrections for deviation from perpendicular must be made.

If necessary and possible, modify the measuring cross section to provide acceptable conditions by building dikes to cut off dead water and shallow flows, remove rocks, weeds, and debris in the reach of stream one or two meters upstream from the measurement cross section. After modifying a streambed, allow the flow to stabilize before starting the flow measurement.

Record the following information on the flow measurement form (see example Flow Measurement Forms at end of this document):

- Station Location and Station ID
- Date
- Time measurement is initiated and ended
- Name of person(s) measuring flow
- Note if measurements are in feet or meters
- Total stream width and width of each measurement section
- For each cross section, record the mid-point, section depth and flow velocity

Measuring the Stream Width

Measure and record the stream width between the points where the tape is stretched (waters edge to waters edge).

Determining the Number of Flow Cross Sections

Determine the spacing and location of flow measurement sections. Some judgment is required depending on the shape of the stream bed. Measurements must be representative of the velocity within the cross-section. If the stream banks are straight and the depth is nearly constant and the bottom is free of large obstructions, fewer measurements are needed, because the flow is homogeneous over a large section. Flow measurement sections do not have to be equal width. However, they should be unless an obstacle or other obstruction prevents an accurate velocity measurement at that point. ***No flow measurement section should have greater than 10% of the total flow.***

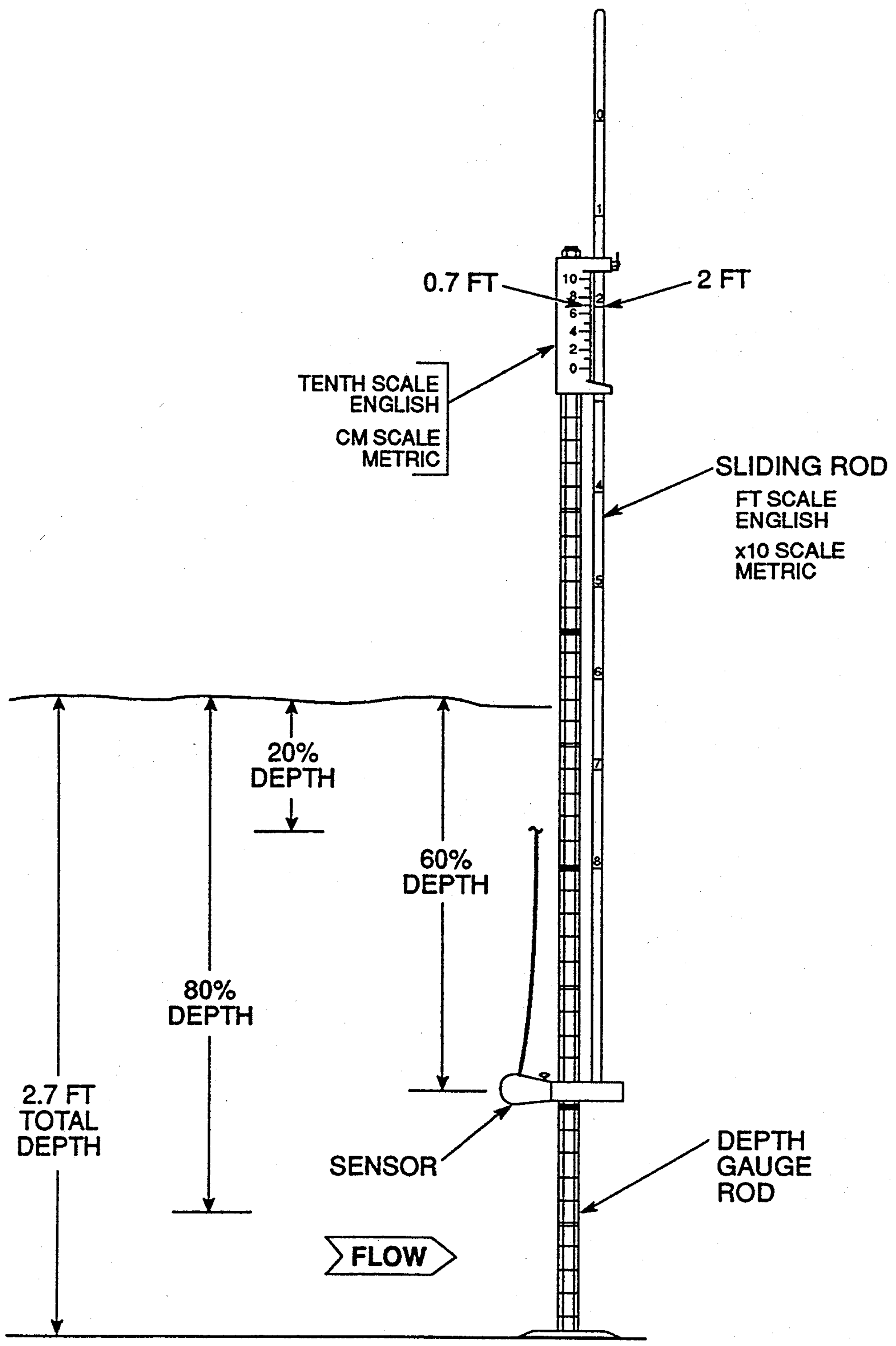
If the *stream width is less than 5 ft*, use flow sections with a width of 0.5 ft (See example 1 on page 23 of this document). If the *stream width is greater than 5 ft*, the minimum number of flow measurements is 10. The preferred number of flow measurement cross sections is 20-30 (See Example 2 on page 24 on this document). The total stream width is 26 ft with 20 measurements, section widths will be 1.3 ft (26/20 = 1.3).

Determining the Mid-Point of the Cross Section

To find the mid-point of a cross section, divide the cross section width in half. Using Example 2 (see forms at end of document);

- The total stream width is 26 ft with 20 cross sections and each cross section width is equal to 1.3 ft.
- Divide 1.3 ft in half and the mid-point of the first section is 0.65 ft. In this example the tape at waters edge is set at zero (0) ft.
- By adding 0.65 to zero the mid-point of the first section is 0.65 ft.
- Each subsequent mid-point is found by adding the section width (1.3 ft) to the previous mid-point. For example; MIDPOINT #1 is 0.65 + 0.0 = 0.65; MIDPOINT #2 is 0.65 + 1.3= 1.95 ft; MIDPOINT #3 is 1.95 + 1.3 = 3.25 ft and ....MIDPOINT # 20 is 24.05 +1.3.
- Place the top setting wading rod at 0.65 ft for the first measurement.
- Using a top setting wading rod, measure the depth at the mid-point of the first flow measurement section and record to the nearest 0.01 ft.

Figure 1. Top-Setting Wading Rod (Marsh-McBirney)



Adjusting the Sensor Depth at a Cross Section

Adjust the position of the sensor to the correct depth at each mid-point. The purpose of the top setting wading rod is to allow the user to easily set the sensor at 20%, 60%, and 80% of the total depth. The total depth can be measured with the *depth gage rod*. Each single mark represents 0.10 foot, each double mark represents 0.50 foot, and each triple mark represents 1.00 foot (see Figure 2).

For Depths < 2.5 Ft	If the depth is less than 2.5 ft, only one measurement is required at each measurement section. To set the sensor at 60% of the depth, line up the foot scale on the *sliding rod* with the *tenth scale*, located on top of the depth gage rod. If, for example, the total depth is 2.7 ft (as shown on Figure 2), then line up the 2 on the foot scale with the 7 on the tenth scale (Marsh-McBirney 1990).
For Depths > 2.5 Ft	If the depth is greater than 2.5 ft, measurements should be taken at 20% and 80% of the total depth.

Measuring Velocity (this has typically been measured at 6/10 of the total depth, for velocity-only measurements)

< Position the meter at the correct depth and place at the mid-point of the flow measurement section. Measure and record the velocity and depth. The wading rod is kept vertical and the flow sensor kept perpendicular to the tape rather than perpendicular to the flow while measuring velocity with an electronic flow meter. When using a propeller or pigmy-type meter, however, the instrument should be perpendicular to the flow.

< Permit the meter to adjust to the current for a few seconds. Measure the velocity for a minimum of 20 s with the Marsh-McBirney and Montedoro-Whitney meters. Measure velocity for a minimum of 40 s (preferably 2 min with the Price and pigmy meters).

< When measuring the flow by wading, stand in the position that least affects the velocity of the water passing the current meter. The person wading stands a minimum of 1.5 ft downstream and off to the side of the flow sensor.

< A flow sensor, equipped with cable and weight may be used to measure flows where the water is too deep to wade. Follow the procedure involving meters attached to wading rods.

< Report flow values less than 10 ft^2 /s to two significant figures. Report flow values greater than 10 ft^3/s to the nearest whole number, but no more than three significant figures.

< In cases where the flow is low and falling over an obstruction, it may be possible to measure the flow by timing how long it takes to fill a bucket of known volume.

Avoid measuring flow in areas with back eddies. The first choice would be to select a site with no back eddy development. However, this can not be avoided in certain situations. Measure the negative flows in the areas with back eddies. These negative values will be included in the final flow calculation.

Calculating Flow

To calculate flow, multiply the width x depth (ft^2) to derive the area of the flow measurement section. The area of the section is then multiplied by the velocity (ft/s) to calculate the flow in cubic feet per second (cfs or ft^3/sec) for that flow measurement section. When flow is calculated for all of the measurement sections, they are added together for the total stream flow (see Figure 2). Flow data transformers are also provided by the SWAMP data management team. The transformer provides the calculations needed to obtain a final flow value in cubic feet per second.

Q=Total Flow (or discharge), W=Width, D=Depth, V=Velocity.

$$Q = (W_1 * D_1 * V_1) + (W_2 * D_2 * V_2) + \ldots\ldots (W_n * D_n * V_n)$$

What to Do with Negative Values

Do not treat cross sections with negative flow values as zero. Negative values obtained from areas with back eddies should be subtracted during the summation of the flow for a site.

Flow Estimate (ft^3/s)

Flow estimate data may be recorded for a non-tidally influenced stream when it is not possible to measure flows by one of the methods described above. Flow estimates are subjective measures based on field personnel's experience and ability to estimate distances, depths, and velocities. If flow can not be measured at a routine non-tidal station, a new site should be selected where flow can be measured.

Flow Estimate Procedure

- Observe the stream and choose a reach of the stream where it is possible to estimate the stream cross section and velocity.
- Estimate stream width (ft) at that reach and record.
- Estimate average stream depth (ft) at that reach and record. Estimate stream velocity (ft/s) at that reach and record. A good way to do this is to time the travel of a piece of floating debris. If doing this method from a bridge, measure the width of the bridge. Have one person drop a floating object (something that can be distinguished from other floating material) at the upstream side of the bridge and say start. The person on the downstream side of the bridge will stop the clock when the floating object reaches the downstream side of the bridge. Divide the bridge width by the number of seconds to calculate the velocity. The velocity can be measured at multiple locations along the bridge. These velocities are averaged. If this is done alone, watch for road traffic.
- Multiply stream width (ft) time’s average stream depth (ft) to determine the cross sectional area (in ft^2) which when multiplied by the stream velocity (in ft/s) and a correction constant, gives an estimated flow (ft^3/s).

__Example__: A stream sampler conducted a sampling visit to a stream while the flow meter was being repaired. The sampler looked at the creek downstream from the bridge and saw a good place to estimate flow. The stream width was around 15 ft. It appeared the average depth on this reach was about 0.75 ft. The sampler timed a piece of floating debris as it moved a distance of 10 ft in 25 s downstream over the reach. An estimated flow with a smooth bottom was calculated using the following formula.

Width x Depth x Velocity x A (correction factor)= estimated flow
15 ft (width) x 0.75 ft (depth) x 2.5 ft/s (velocity) x A =25 ft^3/s (cfs)

A is a correction constant: 0.8 for rough bottom and 0.9 for smooth bottom

Estimated flow should be reported to one or two significant figures.

Experienced field personnel are able to estimate flow to within 20% of actual flow for total flows less than 50 ft^3/s. The best way to develop this skill is to practice estimating flow before making measurements at all monitoring visits to non-tidally influenced flowing streams and then compare estimated flows with those obtained from USGS gages or from instantaneous flow measurements

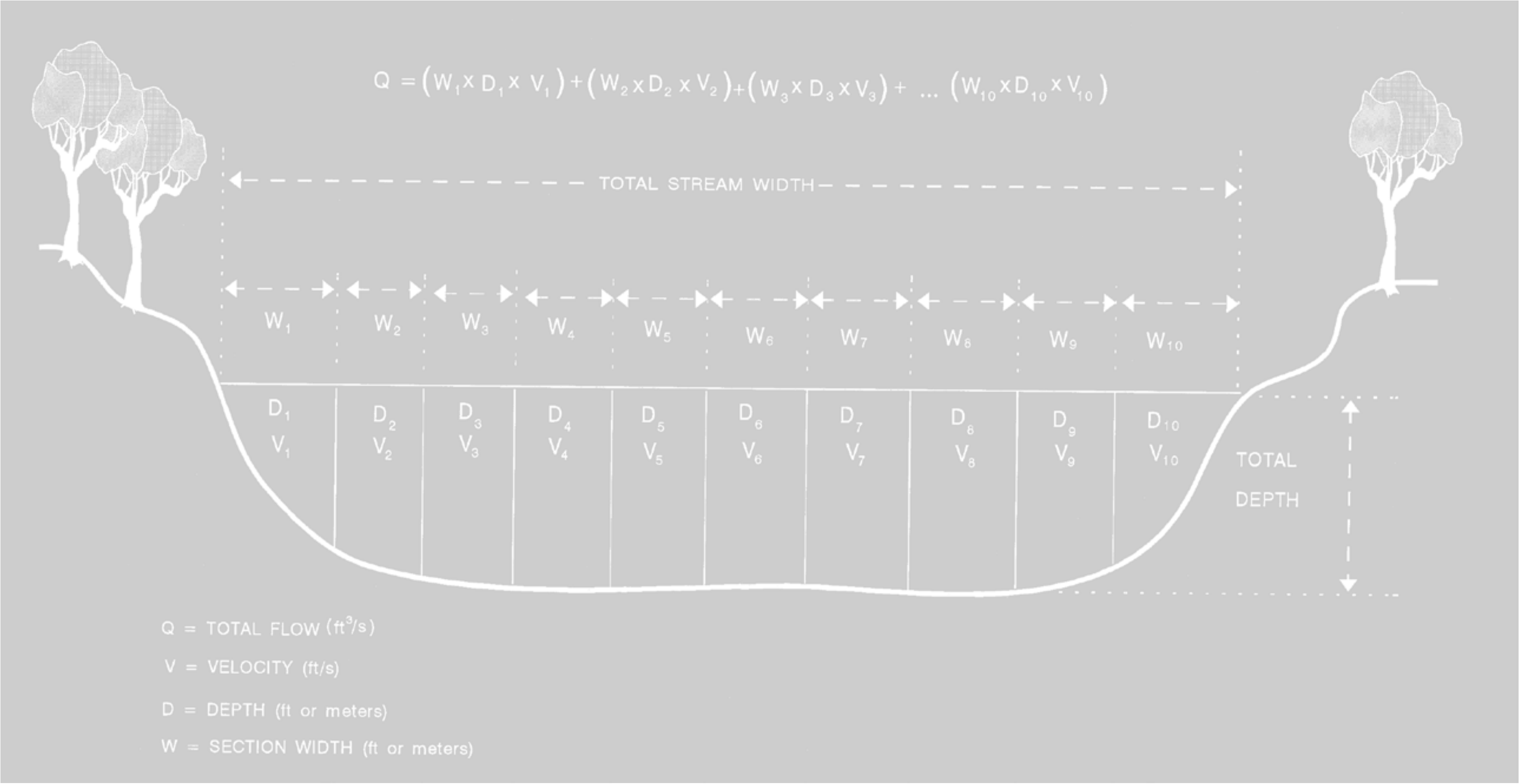


Figure 2. Stream Flow (Discharge) Measurement

Example 1.
Stream Flow (Discharge) Measurement
Small Stream < 5 Ft Wide and #2.5 Ft Deep

Stream:____**OAK CREEK**____Date:__**5/29/91**__________
Station Description:_____**at US Hwy 90A**_________________________________
Time Begin:__**1545**______Time End:__**1630**_______Meter Type:__**Marsh-McBirney**_____________
Observers:_____**BK/MK**_______Stream Width*:____**5 ft**_____ Section Width:____**0.5 ft**__________
Observations:____
____

Section Midpoint (ft)	Section Depth (ft)	Observational Depth** Ft	Velocity		Area W x D (ft^2)	Discharge (Q) V x A (ft^3/s)
			At Point (ft/s)	Average (ft/s)		
0.25	**0.55**			**0.05**		**0.01375**
0.75	**0.80**			**0.11**		**0.044**
1.25	**0.85**			**0.27**		**0.42635**
1.75	**0.90**			**0.49**		**0.2205**
2.25	**1.10**			**0.58**		**0.275**
2.75	**1.50**			**0.72**		**0.540**
3.25	**1.20**			**0.76**		**0.456**
3.75	**0.90**			**0.76**		**0.342**
4.25	**0.75**			**0.44**		**0.165**
4.75	**0.30**			**0.00**		**0.00**

m^3/s x 35.3 =ft^3/s

Total Discharge (3Q) (ft^3/s)	**2.4826**

Example 2: Stream Discharge Measurement **Example (Larger Stream > 5 Ft and #2.5 Ft Deep)**

Stream:____**RED RIVER**____Date:__**5/28/91**___________

Station Description:_____**Post Oak Creek 40 m Below Sherman WWTP Outfall**__________________

Time Begin:__**1542**_____________Time End:__**1601**_____Meter Type:_**Marsh-McBirney**_________

Observers:_____**CM, EW, DO**_______Stream Width*:____**26 ft**___ Section Width:___**1.3 ft**_______

Observations:____

Section Midpoint (ft)	Section Depth (ft)	Observational Depth** ft	Velocity		Area W x D (ft^2)	Discharge (Q) V x A (ft^3/s)
			At Point (ft/s)	Average (ft/s)		
0.65	**0.55**			**2.03**	**0.715**	**1.451**
1.95	**0.40**			**2.04**	**0.520**	**1.061**
3.25	**0.42**			**2.02**	**0.546**	**1.103**
4.55	**0.38**			**1.77**	**0.494**	**0.874**
5.25	**0.40**			**1.75**	**0.520**	**0.910**
7.15	**0.42**			**1.93**	**0.546**	**1.054**
8.45	**0.40**			**1.99**	**0.52**	**1.035**
9.75	**0.37**			**1.92**	**0.481**	**0.924**
11.05	**0.37**			**1.56**	**0.481**	**0.750**
12.35	**0.43**			**1.32**	**0.559**	**0.738**
13.65	**0.40**			**1.36**	**0.520**	**0.707**
14.95	**0.42**			**1.33**	**0.546**	**0.726**
16.25	**0.40**			**1.35**	**0.520**	**0.702**
17.55	**0.45**			**1.64**	**0.585**	**0.959**
18.85	**0.48**			**1.70**	**0.624**	**1.061**
20.15	**0.48**			**2.00**	**0.624**	**1.248**
21.45	**0.50**			**1.95**	**0.650**	**1.268**
22.75	**0.40**			**2.18**	**0.520**	**1.134**
24.05	**0.48**			**1.71**	**0.624**	**1.067**
25.35	**0.50**			**0.60**	**0.650**	**0.390**
			Total Discharge (3Q) (ft^3/s)			**19.162**

m^3/s x 35.3 =ft^3/s

Example 3: Stream Flow (Discharge) Measurement (Larger Stream > 5 Ft and >2.5 Ft Deep)

Stream:____ARROYO COLORADO________________________________Date:__**6/16/98**__________

Station Description:_____Downstream of Harlingen WWTP____________________________________

Time Begin:__**1400**______Time End:__**1445**_____Meter Type:___**Marsh-McBirney**______________

Observers:_____**JD, CK**________Stream Width*:___**47.5 ft**___ Section Width:___**2.375 ft**________

Observations: *Note that the starting point is at 4.7 ft on the measuring tape and not zero.

Section Midpoint (ft)	Section Depth (ft)	Observational Depth** ft	Velocity		Area W x D (ft^2)	Discharge (Q) V x A (ft^3/s)
			At Point (ft/sec)	Average (ft/sec)		
4.70	**0.73**			**0.65**	**1.73**	**1.127**
7.08	**1.10**			**1.08**	**2.61**	**2.822**
9.45	**1.85**			**0.90**	**4.39**	**3.954**
11.83	**2.20**			**1.05**	**5.23**	**5.486**
14.20	**2.20**			**1.44**	**5.23**	**7.531**
16.58	**2.45**			**1.09**	**5.82**	**6.342**
18.95	**2.55**	**0.20**	**1.75**	**1.76**	**6.06**	**10.659**
		0.80	**1.76**			
21.33	**2.60**	**0.20**	**1.79**	**1.56**	**6.18**	**9.633**
		0.80	**1.32**			
23.70	**2.70**	**0.20**	**1.63**	**1.45**	**6.41**	**9.298**
		0.80	**1.26**			
26.10	**3.05**	**0.20**	**1.68**	**1.42**	**7.24**	**10.286**
		0.80	**1.15**			
28.48	**3.10**	**0.20**	**1.23**	**0.96**	**7.36**	**7.068**
		0.80	**0.69**			
30.85	**2.90**	**0.20**	**1.22**	**1.06**	**6.89**	**7.301**
		0.80	**0.89**			
33.23	**2.84**	**0.20**	**0.60**	**0.49**	**6.75**	**3.305**
		0.80	**0.37**			
35.60	**2.65**	**0.20**	**0.80**	**0.51**	**6.29**	**3.210**
		0.80	**0.21**			
37.98	**2.65**	**0.20**	**0.85**	**0.91**	**6.29**	**5.727**
		0.80	**0.96**			
40.35	**2.20**			**0.28**	**5.23**	**1.464**
42.73	**2.30**			**0.16**	**5.46**	**0.874**
45.10	**2.05**			**0.51**	**4.87**	**2.483**
47.48	**1.10**			**0.49**	**2.61**	**1.280**
49.86	**0.65**			**0.62**	**1.54**	**0.957**

m^3/s x 35.3 $=ft^3/s$

Total Discharge (3Q) (ft^3/s)

Stream Flow (Discharge) Measurement Form

Stream:____Date:_____________

Station Description:____

Time Begin:_________ Time End:___________ Meter Type:_____________________

Observers:________________ Stream Width*:____________ Section Width:_________

Observations:____

Section Midpoint (ft) (m)	**Section Depth (ft) (m) (cm)**	**Observational Depth** ft-m-cm**	**Velocity**		**Area W x D (ft^2) (m^2)**	**Flow (Q) V x A (m^3/s) (ft^3/s)**
			At Point (ft/s) (m/s)	**Average (ft/s)(m/s)**		

m^3/s x 35.3 =ft^3/s

Total Flow (Discharge) (3Q) (ft^3/s)	

Make a minimum of 10 measurements when the total width is > 5.0 ft, 20 measurements preferred.

If the depth is less than 2.5 ft, only one measurement is required at each measurement section. To set the sensor at 60% of the depth, line up the foot scale on the *sliding rod* with the *tenth scale*, located on top of the depth gage rod. If, for example, the total depth is 2.7 ft (as shown on Figure 2), then line up the 2 on the foot scale with the 7 on the tenth scale (Marsh-McBirney 1990). If the depth is greater than 2.5 ft, measurements should be taken at 20% and 80% of the total depth.

Summary of Significant Figures for Reporting Field Parameters

Parameter	Field Data Reporting Requirements
Water Temperature (^{o}C)	Report temperature to the nearest tenth of a degree. Round insignificant figures 0 through 4 down and 5 thru 9 up.
pH (s.u.)	Report pH to the nearest tenth of a pH standard unit.
D.O. mg/L **D.O.** (% saturation)	Report dissolved oxygen to the nearest tenth of a mg/L. Report % saturation to the nearest tenth of a percent
Specific Conductance (micro siemens/cm)	Report specific conductance to only three significant figures if the value exceeds 100. Do not report ORP which is displayed by some multi-probes.
Salinity (ppt)	Report salinity values above 2.0 ppt to the nearest tenth of a part per thousand. In estuarine waters report the actual values displayed by the multi-probe above 2.0 ppt and values less than 2.0 as <2.0 or <1.0 only. Determine if a station is estuarine (i.e., experiences cases where salinity is >2.0 ppt) and always report salinity at this station, regardless of the salinity during periods of high flow.
Secchi Disk (meters)	Report Secchi depth transparency in meters to two significant figures.
Flow (ft^3/s)	Report instantaneous flow values less than 10 ft^3/s to two significant figures. Report flow values greater than 10 ft^3/s to the nearest whole number, but no more than three significant figures. When there is no flow (pools), report as 0.0. When there is no water, don't report a value, but report as "dry" in the observations.

BEAUFORT SCALE: Specifications and equivalent speeds for use at sea

FORCE	**EQUIVALEN SPEED 10 m above ground**		**DESCRIPTION**	**SPECIFICATIONS FOR USE AT SEA**
	Miles/hour	knots		
0	0-1	0-1	Calm	Sea like a mirror
1	1-3	1-3	Light air	Ripples with the appearance of scales are formed, but without foam crests.
2	4-7	4-6	Light Breeze	Small wavelets, still short, but more pronounced. Crests have a glassy appearance and do not break.
3	8-12	7-10	Gentle Breeze	Large wavelets. Crests begin to break. Foam of glassy appearance. Perhaps scattered white horses.
4	13-18	11-16	Moderate Breeze	Small waves, becoming larger; fairly frequent white horses.
5	19-24	17-21	Fresh Breeze	Moderate waves, taking a more pronounced long form; many white horses are formed. Chance of some spray.
6	25-31	22-27	Strong Breeze	Large waves begin to form; the white foam crests are more extensive everywhere. Probably some spray.
7	32-38	28-33	Near Gale	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.
8	39-46	34-40	Gale	Moderately high waves of greater length; edges of crests begin to break into spindrift. The foam is blown in well-marked streaks along the direction of the wind.
9	47-54	41-47	Severe Gale	High waves. Dense streaks of foam along the direction of the wind. Crests of waves begin to topple, tumble, and roll over. Spray may affect visibility.
10	55-63	48-55	Storm	Very high waves with long over- hanging crests. he resulting foam, in great patches, is blown in dense white streaks along the direction of the wind. On he whole the surface of the sea takes on a white appearance. The 'tumbling' of the sea becomes heavy and shock-like. Visibility affected.

Last edited on 09 January, 1999 Dave Wheeler weatherman@zetnet.co.uk
Web Space kindly provided by Zetnet Services Ltd, Lerwick, Shetland.
http://www.zetnet.co.uk/sigs/weather/Met_Codes/beaufort.htm

Field Collection Procedures for Water Samples

Scope and Application

This protocol describes the techniques used to collect water samples in the field in a way that neither contaminates, loses, or changes the chemical form of the analytes of interest. The samples are collected in the field into previously cleaned and tested (if necessary) sample bottles of a material appropriate to the analysis to be conducted. Pre-cleaned sampling equipment is used for each site, whenever possible and/or when necessary. Appropriate sampling technique and measuring equipment may vary depending on the location, sample type, sampling objective, and weather. Trade names used in connection with equipment or supplies do not constitute an endorsement of the product. Safety equipment is always used while water sampling including gloves, waders and eye protection. Safety equipment helps to protect the sampler from potential contaminants and to prevent sample contamination.

Summary of Method

Appropriate sample containers and field measurement gear as well as sampling gear are transported to the site where samples are collected according to each sample’s protocol. Water velocity, turbidity, temperature, pH, conductivity, dissolved oxygen as well as other field data are measured and recorded using the appropriate equipment. These field data measurement protocols are provided in this Field Measurement SOP. Samples are immediately put on ice and appropriately shipped to the authorized laboratories. This procedure has been modified from the Texas Natural Resources Conservation Commission’s Procedure Manual for Surface Water Quality Monitoring, with major input from the United State’s Geological Survey’s (USGS’s) National Water Quality Assessment (NAWQA) Protocol for Collection of Stream Water Samples.

WATER SAMPLE COLLECTION

Water chemistry and bacteriological samples, as requested, are collected at the same location. *Water samples are best collected before any other work is done at the site*. If other work (e.g., sediment sample collection, flow measurement or biological/habitat sample collection or assessment) is done after or downstream of the collection of water samples, it might be difficult to collect representative samples for water chemistry and bacteriology from the disturbed stream. Care must be taken, though, to not disturb sediment collection sites when taking water samples. Don’t be trampling where you are sampling.

The following general information applies to all types of water samples, unless noted otherwise:

Sample Collection Depth

Sub-Surface Grab Sample Samples are collected at 0.1 m below the water surface. Containers should be opened and re-capped under water in most cases.

Depth-integrated Sample If a depth-integrated sample is taken, the sample is pumped from discrete intervals within the entire water column.

Surface Grab Sample Samples are collected at the surface when water depth is <0.1 m. Since there is a difference in water chemistry on the surface, compared to subsurface, surface water should be noted on the field data sheet as 0 m.

Where to Collect Samples

Water samples are collected from a location in the stream where the stream visually appears to be completely mixed. Ideally this would be at the centroid of the flow (*Centroid* is defined as the midpoint of that portion of the stream width, which contains 50% of the total flow), but depth and flow do not always allow centroid collection. For stream samples, the sampling spot must be accessible for sampling physicochemical parameters, either by bridge, boat or wading. Sampling from the shoreline of any water body (meaning standing on shore and sampling from there) is the least acceptable method, but in some cases is necessary.

In reservoirs, lakes, rivers, and coastal bays, samples are collected from boats at designated locations provided by Regional Water Quality Control Boards (Regional Boards). Samples from boats should be collected where the vessel does not interfere with the water being collected.

Sampling Order if Multiple Media are Requested to be Collected

The order of events at every site has to be carefully planned. For example, if sediment is to be collected, the substrate can not be disturbed by stepping over or on it; water samples can not be collected where disturbed sediment would lead to a higher content of suspended matter in the sample. *For the most part, water samples are best collected before any other work is done at the site*. This information pertains to walk-in sampling.

Sample Container Labels

Label each container with the station ID, sample code, matrix type, analysis type, project ID, and date and time of collection (in most cases, containers will be pre-labeled). After sampling, secure the label by taping around the bottle with clear packaging tape.

Procedural Notes

For inorganic and organic water samples, bottles do not have to be rinsed if they are I-Chem 200 series or higher or ESS PC grade or higher. This means that the sample bottles are analyzed for contamination, and a certification of analysis is included with the bottles. Other sample containers are usually rinsed at least three times if the bottles do not meet these requirements. See filling instruction for each type of analyses if there is uncertainty. If applicable to the sample and analysis type, the sample container should be opened and re-capped under water.

Sample Short-term Storage and Preservation

Properly store and preserve samples as soon as possible. Usually this is done immediately after returning from the collection by placing the containers on bagged, crushed or cube ice in an ice chest. Sufficient ice will be needed to lower the sample temperature to at least 6 ° □(time of collection. Sample temperature will be maintained at 6 °□C until delivered to the laboratory. Care is taken at all times during sample collection, handling and transport to prevent exposure of the sample to direct sunlight. Samples are preserved in the laboratory, if necessary, according to protocol for specific analysis (acidification in most cases).

Field Safety Issues

Proper gloves must be worn to prevent contamination of the sample and to protect the sampler from environmental hazards (disposable polyethylene, nitrile, or non-talc latex gloves are recommended, **however, metals and mercury sample containers can only be sampled and handled using clean polyethylene gloves as the outer layer**). Wear at least one layer of gloves, but two layers help protect against leaks. One layer of shoulder high gloves worn as a first (inside) layer is recommended to have the best protection for the sampler. Safety precautions are needed when collecting samples, especially samples that are suspected to contain hazardous substances, bacteria, or viruses.

Sample Handling and Shipping

Due to increased shipping restrictions, samples being sent via a freight carrier require additional packing. Although care is taken in sealing the ice chest, leaks can and do occur. Samples and ice should be bagged placed inside a large trash bag inside the ice chest for shipping. Ice should be double bagged to prevent melted ice water from leaking into the sample. The large trash bag can be sealed by simply twisting the bag closed (while removing excess air) and taping the tail down. Prior to shipping the drain plug of the ice chests have to be taped shut. Leaking ice chests can cause samples to be returned or arrive at the lab beyond the holding time.

Although glass containers are acceptable for sample collection, bubble wrap must be used when shipping glass.

Chain of Custody (COC) Forms

Every shipment must contain a complete Chain of Custody (COC) Form that lists all samples collected and the analyses to be performed on these samples.

Make sure a COC is included for every laboratory, every time you send a shipment of samples. Electronic COC’s can also be emailed to the various laboratories but must be sent before the samples arrive at their destinations.

Include region and trip information as well as any special instructions to the laboratory on the COC.

The original COC sheet (not the copies) is included with the shipment (insert into ziplock bag) One copy goes to the sampling coordinator, and the sampling crew keeps one copy.

Samples collected should have the salinity (in parts per thousand) or specific conductivity **(µS/cm),** depth of collection, and date/time collected for each station on every COC.

Write a comment on this form, if you want to warn the laboratory personnel about possibly hazardous samples that contain high bacteria, chlorine or organic levels.

Field QC Samples for Water Analyses

Field duplicates are currently submitted at an annual rate of 5%. Field travel blanks are required for volatile organic compounds at a rate of one per cooler shipped. Field blanks are required for trace metals (including mercury and methyl mercury), DOC, and volatile organic compounds in water at a project rate of 5%. See the SWAMP Quality Control and Sample Handling Guidelines for information regarding frequency and types of field QC samples.

SWAMP Field Data Sheets

Each visited field site requires a field observation completed SWAMP Field Data Sheet, even if no samples are collected (i.e. at a site which is found to be dry). If water and/or sediment samples are collected, all elements of the SWAMP Field Data Sheet must be completely filled out. Data sheets are provided from the SWAMP Data Management Resources website at: **Water Quality Field Data Sheet** *(updated 12/18/12)*

General Pre-Sampling Procedures

Instruments. All instruments must be in proper working condition. Make sure all calibrations are current. Multi-probe sondes should be pre-calibrated every morning prior to sampling and post-calibrated within 24 h of the original calibration. Conductivity should also be calibrated between stations if there is a significant change in salinity. Dissolved oxygen sensors should be re-calibrated if there is a 500 ft change in elevation.

Calibration Standards. Pack all needed calibration standards.

Sample Storage Preparations. A sufficient amount of cube ice, blue ice and dry ice as well as enough coolers of the appropriate type/size must be brought into the field, or sources for purchasing these supplies identified in advance.

Sample Container Preparation. After arriving at the sample station, pack all needed sample containers for carriage to the actual collection site, and label them with a pre-printed label containing Station ID, Sample Code, Matrix info, Analysis Type info, Project ID and blank fields for date and time (if not already pre-labeled).
Safety Gear. Pack all necessary safety gear like waders, protective gloves and safety vests.

Walk to the site. For longer hikes to reach a sample collection site, large hiking backpacks are recommended for transport of gear, instruments and containers. Tote bins can be used, if the sampling site can be accessed reasonably close to the vehicle.

GPS. At the sampling site, compare/record reconnaissance GPS reading with current site reading and note differences. GPS coordinates should be in Decimal Degrees (e.g. 38.12345 -117.12345).

COLLECTION OF WATER SAMPLES FOR ANALYSIS OF CONVENTIONAL CONSTITUENTS

In most streams, sub-surface (0.1 m below surface) water is representative of the water mass. A water sample for analysis of conventional constituents is collected by the grab method in most cases, immersing the container beneath the water surface with the cap on to a depth of 0.1 m. Remove cap and fill container replacing the cap before removing the container from the water. Sites accessed by bridge can be sampled with a sample container-suspending device. Extreme care must be taken to avoid contaminating the sample with debris from the rope and bridge. Care must also be taken to rinse the device between stations. If the centroid of the stream cannot be sampled by wading, sampling devices can be attached to an extendable sampling pole. It should be noted on the field data sheet if using a bucket sampler that surface water is entering the sample bottle.

In some cases, depth-integrated sampling is required, as requested by Regional Boards. This is useful when lakes or rivers are stratified and a sample is wanted that represents the entire water column. Depth-integrated sample collection is explained later in this document.

Conventional Water Constituents, Routinely Requested in SWAMP	Chloride (Cl-), Sulfate ($SO4^{2-}$), Nitrite ($NO2^{-}$), Nitrate ($NO3^{-)}$ (or Nitrate + Nitrite ($NO_3 + NO_2$)), Ortho-phosphate, Fluoride (F-), Total Phosphorus (TPO_4), Ammonia (NH3), Total Nitrogen (TN), Alkalinity, Chlorophyll a.
Conventional Water Constituents, Occasionally Requested in SWAMP	Total Suspended Solids (TSS) or Suspended Sediment Concentration (SSC), Total Dissolved Solids (TDS--especially if total metals requested), Total Kjeldahl Nitrogen (TKN), Total Organic Carbon (TOC), Dissolved Organic Carbon (DOC), hardness (if trace metals analysis is requested).
Conventional Water Constituents Sample Volume	Due to the potential for vastly different arrays of requested analyses for conventional constituents, please refer to table at the end of this document, as well as the Quality Control and Sample Handling Guidelines for Conventional Parameters, for

information on the proper volume to collect for the various types of analyses.

Conventional Water Constituents Sample Container Type

Due to the potential for vastly different arrays of requested analyses for conventional constituents, please refer to table at the end of this document, as well as the Quality Control and Sample Handling Guidelines for Conventional Parameters, for information on the proper type of sample containers.

Chlorophyll a Syringe Sample Method

Chlorophyll a syringe method: Chlorophyll a is sampled by forcing water with a 60-mL syringe through a filter holder containing a 25-mm glass microfiber filter. The 60-mL syringe and an in-line filter holder are rinsed three times with the ambient water before filtration. The syringe is then filled with 60 mL of ambient water. The filter holder is then removed and a 25-mm glass microfiber filter is placed inside. The filter holder is then screwed onto the syringe and the ambient water is then flushed through the filter. The filter holder is removed every time more water needs to be drawn into the syringe. The process is then repeated until the desired amount of Chlorophyll a is present (usually 60 to 360 mL depending on the water clarity). When filtering is complete the filter holder is opened and the filter is removed with tweezers without touching the Chlorophyll a. The filter is then folded in half, then again, in half with the Chlorophyll a inside the folds. The folded filter is then wrapped in aluminum foil and placed in an envelope labeled with the site information and the volume filtered. The envelope is then immediately placed on dry ice until transferred to the lab.

Collection of Water Samples for Analysis of Trace Metals (Including Mercury)

When deciding to measure total and dissolved metals in water the purpose of the sampling must be considered. Water quality standards for the protection of aquatic life are determined for the dissolved form of heavy metals in most cases, although this, too, can vary within different Basin Plans for different regions. The exception to routinely conducting dissolved metals analyses is usually mercury (and often selenium). Water quality standards usually apply to the total form of mercury (and often selenium), and not the dissolved form of these elements. Several regions are interested in conducting total metals analyses, in order to address specific issues. In order to budget inputs, transport, and accumulation of metals, it is necessary to know the concentration of total metals in the water column, sediments, effluent, etc. Sample collection for trace metals and mercury in water requires "Clean Hands/Dirty Hands" methodology.

Metals-in-water:

General Information

Unless otherwise requested to collect for total metals analysis, dissolved metals are collected for all elements with the exception of mercury. Metals-in-water samples should **not** be collected during periods of abnormally high turbidity if at all possible. Samples with high turbidity are unstable in terms of soluble metals, and it is difficult to collect a representative grab sample. Special study sampling, however, may be an exception. For example, wet weather sampling is likely to include some samples with high turbidity.

Metals-in-water:

Sample Collection Depth

Collect a metals sample from a depth of 0.1 m using a sub - surface grab method, or at discrete depths using a depth-integrated sampling method with a peristaltic pump (described further down). In most streams, sub-surface water is representative of the water mass. For the purpose of determining compliance with numerical toxic substance standards, a sample taken at the surface is adequate.

Metals-in-water:

Sample Volume

Refer to table at end of this document for specific information on the proper volume to collect for trace metals analyses. Generally, for procedures most commonly used for analysis of metals in water (total or dissolved metals); one 60-mL polyethylene container is filled with the salinity recorded on the field data sheet and COC. Generally, for the procedures most commonly used for analysis of mercury in water (whether total or dissolved), one 250-mL glass or teflon container is filled, regardless of the salinity. All containers are pre-cleaned in the lab using HNO_3.

Metals-in-water:

Sampling Equipment

The method of choice for the collection of water samples for trace metals analysis in small, wadeable streams is the grab method, where the sampler submerges the sample bottle or syringe beneath the surface of the water until filled. The procedure for filtration of water samples for trace metals analysis must be performed within 15 minutes of collection to meet the required filtration holding time. For Mercury(Hg) samples, preservation may take place in the field or at the laboratory within 48 hours of collection. Extreme care must be taken to avoid contamination of the water sample. Considering these factors, it is best to use a **field** filtration system, such as a set-up with peristaltic pump with in-line filter, or a set-up with a syringe filter, if filtered water is required. Samples are pumped and/or filtered directly into the sample container. This minimizes contamination by using no intermediate sampling device. Samples can also be filtered in lab if need be Un-powdered (no-talc) polyethylene gloves are always worn during sampling for metals-in-water.

Depth-integrated sampling is useful when lakes or rivers are stratified and a representative sample is wanted which represents the entire water column. The method involves a peristaltic pump system with enough Teflon tubing to pump at the desired depth with an inline filter. Filter equipment blanks are analyzed for five percent of all cleaned equipment.

Equipment Preparation

It is best if the metals-in-water sampling materials are prepared by a laboratory that can guarantee contamination-free sampling supplies. If a laboratory assembles a Metals-in-Water Sample Collection Kit, it should contain the following items packaged together **for each sample**:

- Tubing with an in-line filter (disposable, 0.45 µm) attached for dissolved metals-in-water sampling. This same tubing is used for total metals-in-water samples without filter. If an in-line pumping system is not used, an acid cleaned syringe and filter are packed.
- Sample containers- polyethylene for total and dissolved samples and blanks; Glass or Teflon for total and dissolved mercury.
- Acid preservation is performed in the laboratory.
- Metals-free DI water (for blanks).
- Powder-free polyethylene gloves

If a laboratory is not assembling collection kits, individuals should take care to keep containers in the original packaging. When removed from the box, sample containers are placed in clean plastic bags (zipper closure bags). Although filters come individually wrapped, they should also be stored in new zipper closure bags to avoid possible contamination.

The filtering equipment is pre-cleaned according to laboratory protocol. Clean tubing is put into clean containers, such as large zipper closure bags. Metals-free filter cartridges with the capacity to filter several liters are commercially available. Equipment blanks are run at the laboratory on batches of metals-in-water sampling equipment prior to their distribution to field staff. One to two liter containers with metals-free deionized water are taken into the field for travel blanks. Metals-free deionized water is supplied by the laboratory performing metals analysis. The deionized water containers are kept clean and dust-free on the outside by wrapping in two plastic bags.

Dissolved and Total Metals-in-Water: Detailed Collection Techniques

- ***Sub-Surface Grab Method***
- ***Syringe Filtration Method (for sub- surface collection)***
- ***Peristaltic Pumping Method (Using Tubing/In-line Cartridge Filters)for sub- surface collection or for depth-integrated collection***

Metals-in-water Sample Collection:

Sub-Surface Grab Method

Clean Hands/Dirty Hands Technique

Unfiltered Samples (for total metals analysis, if requested, and for mercury almost always, unless otherwise requested): Some samples can be sampled directly from the ambient water either by wading into the stream and dipping bottles under the surface of the water until filled, or by sampling from a boat and dipping the bottle under the surface of the water until it is filled. The bottles are cleaned according to laboratory protocol. It is very critical that all the acid is rinsed out of the bottles before the samples are collected. Personnel involved in field sample collection/processing wear polyethylene gloves. The laboratory pre-cleaned glass or Teflon™ 250 mL (for mercury) or polyethylene 60 mL (for metals) sample bottles are taken from the double-wrapped zipper closure plastic bags using “Clean Hands/Dirty Hands” techniques. The dirty hands collector opens the first outer bag, and the clean hands collector opens the inner bag around the bottle. The clean hands collector then removes the bottle from the inner bag. Clean hands collector then places the inner bag back inside the outer bag while sampling occurs. The clean hands collector dips the bottle into the ambient water, with the cap on, to approximately 0.1 m (avoiding disturbing surface scums), placing the cap back on the bottle before being removed from the water, rinses the bottle five times with ambient water, making sure the threads of the bottle get rinsed as well, and fills the bottle to the top. The lid is secured under the water surface and the bottle is put back into the inner clean bag and sealed by the clean hand collector. The sealed clean bag is then placed back inside the outer bag by the clean hands collector. The dirty hands collector then seals the outer bag.

Metals-in-water Sample Collection:

Syringe Filtration Method (for sub-surface collection)

Filtered Samples (for dissolved metals analyses): Sub-surface water samples are filtered for dissolved trace metals analysis (not for mercury, however, in almost all cases) using the following syringe filtration method.

The syringe (60 cc size, pre-cleaned in the laboratory) and in-line filter are pre-packed in two zipper closure bags. The syringe and filter are taken out of the bags using “Clean Hands/Dirty Hands” technique, as previously described. The sub-surface water sample is collected by 1) wading out into the centroid portion of the stream, or by leaning over the edge of the boat, and aspirating water into the syringe, filling and rinsing the syringe five times with ambient water; 2) attaching the filter onto the syringe and filling the syringe body; 3) rinsing the filter with a few milliliters of the sample; 4) rinsing the sample bottle five times with the filtered ambient water; and 5) extruding the sample through the syringe filter and completely filling each bottle. The bottles are taken out of and put back into their bags using “Clean Hands/Dirty Hands”.

Metals-in-water Sample Collection--

Peristaltic Pump

The basic “Clean Hands/Dirty Hands” technique is also applied in the use of a peristaltic pump with an in-line filter cartridge for metals-in-water sample collection. Dirty Hands removes the plastic cover from the end of the pump tubing and inserts the tubing into the sampling container. Dirty Hands holds the tubing in place. The in-line cartridge filter is attached to the outlet end of the tubing.

Clean Hands takes the plastic cover off the other end of the tubing. Dirty Hands turns on the pump and flushes lL of ambient water through the tubing to purge it for dissolved metals.

Clean Hands removes the cap from the sample bottle and uses the pump to fill it with ambient water. Clean Hands puts the cap back on the bottle and places it in the plastic bag.

Metals-in-water Sample Collection:

Depth-Integrated Sampling, using In-line Cartridge Filter and Peristaltic Pump

Preparation for Depth-integrated sample collection: Depth-integrated sampling is useful when lakes or rivers are stratified, and a representative sample is wanted that represents the entire water column to the extent possible. The method utilized to date for SWAMP involves a peristaltic pump system with enough Teflon tubing to pump from the desired depth. Regional Boards must request depth-integrated sampling.

The tubing set consists of a small length of CFLEX tubing that fits in the peristaltic pump, with an appropriate length of Teflon tubing on the suction side of the pump and a 3-ft section of Teflon tubing on the discharge side of the pump.

The tubing set is pre-cleaned in 10% reagent grade HCL at the laboratory, and to date in SWAMP, a new pre-cleaned tubing set is used for each site. However, the same peristaltic tubing set <u>can</u> be used at multiple sites, as long as it has been cleaned in the field between stations, according to protocol as outlined below. If this is to be done, however, and Dissolved or Total Organic Carbon samples are collected, equipment blanks should be collected at each site until it is determined that the blanks are acceptably low.

The field cleaning procedure for tubing that is to be re-used is:

- Pump phosphate free detergent through tubing.
- Pump 10% HCL through tubing.
- Pump methanol through tubing.
- Pump 1 l of blank water (Milli-Q) through.

All reagents must be collected in appropriate hazardous waste containers (separated by chemical), and transport, as well as disposal, must follow appropriate local, state, and federal regulations.

If a field blank is needed, collect it after the 1 L of blank water is pumped through. Pump the amount of ambient water equivalent to 3 times the volume of the tubing before sampling the next site.

Filtered and Unfiltered Samples, Depth-integrated:
It is recommended to attach the tubing to a line with depth measurement markers (preferably in meters). At the end of this line should be a trace metal-safe weight, which hangs about one meter below the tubing end, avoiding any sediment intake from the bottom of the water column with the pump tubing.

At the site, Dirty Hands sets up the pump, while Clean Hands takes a bottle from the plastic bag and places it in a container holder or on a clean surface. A container holder can be anything trace metal clean that supports the bottle, freeing up the collector’s hands. Clean Hands takes the outlet-end of the tubing (with the in-line filter cartridge attached) out of the bag, and places it in the peristaltic pump head. The outlet end is long enough to allow easy bottle filling; the other end is long enough to easily reach beneath the water surface and to the desired depth. Dirty Hands closes the pump head, locking the tubing in place.

Make sure that all bottles are filled with a depth-integrated water sample. This can be accomplished by dividing the total vertical length of the water column into 2 to 10 equal intervals, and sampling each interval equally, filling the bottles at each depth proportional to the number of intervals sampled. For example, if 10 intervals are sampled, every bottle is filled 1/10th full at each depth sampled. A very common method of dividing the water column is by first determining the depth of the thermo-cline. Samples are taken at the midpoint between the surface and the thermo-cline, at the midpoint between the top of the thermo-cline and the bottom of thermo-cline, and at the midpoint between the bottom of the thermo-cline and just above the bottom of the water column. For these methods, all containers have to be filled at the same time. Note the number of intervals sampled on the data sheet.

When filling bottles, Clean Hands immerses the intake tube directly into the water at the appropriate depth, and Dirty Hands operates the pump to flush the tubing with a minimum of 1L of ambient water through the tubing and filter.

Clean Hands removes the cap from the sample bottle, holds the tubing outlet with the in-line filter cartridge over the container opening (without touching the container), and allows the container to fill. The container is filled and rinsed five times with ambient water, and is then filled to the top for the actual sample. Clean Hands puts the cap back on the bottle, and places the bottle back it in the zipper closure plastic bag. Whenever Clean Hands touches the boat or equipment, which may be contaminated, gloves should be changed immediately.

<u>(Note for Unfiltered samples:</u> *If an unfiltered sample is required for total metals, total mercury, conventional constituents, toxicity, or synthetic organics, the same procedure is used as described above, except the filter is detached from the end of the tubing before filling the bottles.)*

When sampling is finished, the tubing is brought to the surface, clean water (Milli-Q or deionized) is pumped through system, and the tubing is stored in a polyethylene bag.

The tubing set can be used at multiple sites, as long as it has been cleaned in the field between stations (see field cleaning procedure above). However, if Dissolved or Total Organic Carbon samples (in water) are collected, equipment blanks should be collected at enough sites until it is determined the blanks are appropriate.

Metals-in-water Sample Collection:

Composite Bottle

Collecting the Sample:

The sample collection methodologies are identical to those described above except the sample is collected first into a composite bottle(s). The sample is collected in an amber glass 4-L bottle for mercury and methyl mercury, and a 4-L polyethylene bottle for other trace metals. The compositing bottle is cleaned according to SWAMP SOP.SC.G.1. It is very critical that all the acid is rinsed out of the bottle and that the bottle is rinsed with sample water (five times) before the sample is taken. The sample is collected by the grab or pumping method after being rinsed five times with ambient water and is brought inside the water quality vehicle or sampling box for processing. Personnel involved in sample processing don polyethylene gloves. During sampling the dirty hands person opens the bag holding the composite bottle and opens the outer plastic bag. The clean hands person opens the inner plastic bag, removes the bottle and holds the bottle while the Dirty Hands sampler controls the flow of water through the pump into the bottle.

Preparing sample aliquots from a composite bottle into smaller sample bottles using an inline pump and filter:

The dirty hands person opens the first bag, and the clean hands person opens the inner bag around the composite bottle. The clean hands person then removes the bottle from the inner bag and places the bags and the bottle in a designated clean place.

This process is repeated until all sample bottles are lined up on the clean bench with their tops still on.

The top of the bottles are loosened so that they fit very loosely on top of the bottles so the clean hands person can remove the caps and pour or pump water into the bottles easier.

The clean hands person shakes the 4-L sample in a steady and slow up and down motion for two full minutes.

Samples that are not to be filtered (including TSS/SSC) are sub-sampled out of the bottle by pouring out of the large compositing bottle into the sample bottles. The compositing bottle is shaken for 15 s between these subsamples.

Each sample bottle is rinsed five times with ambient water before filling.

For the clean pumping system setup procedure, see above.

(The equipment or field blank is processed exactly like a sample following the same steps.)

The clean end of the tubing used for suction is placed into 1 L bottle. Approximately 750 mL of Milli-Q are then pumped through the system to purge any residual contamination.

The 250-mL sample bottles are then filled to the neck and capped as soon as possible.

Note: if volatile organics are to be collected they should be pumped directly into the sample containers before the compositing procedure.

Metals-in-water:

Short-term Sample Preservation

After collecting the sample, the double-bagged container is placed in another plastic bag for shipping, and placed on ice in the ice chest, cooled to 6 °C. This is to prevent possible contamination from other samples in the ice chest. Metals-in-water samples are acid-preserved in the lab.

Metals-in-water:

Sample Container Label

Label each outer sample-bag with the station ID, sample code, matrix type, analysis type, project ID, and date and time of collection.

Metals-in-water:

Field Equipment Blank

Pumping Method. If required, field blanks are collected at the last site of a sampling trip, with the same tube and filter used to collect the last dissolved metals-in-water sample of the day (before the ambient sample is collected); and with the tube used for the last total metals-in-water sample of the day. If each sample is taken using a new set of tubing, a separate tubing-set should be used for the blank.

The same Clean Hands/Dirty Hands collection techniques are followed for the field blank as the samples, pumping trace metal-free water from a clean container supplied by the laboratory.

Syringe Method. If required, field blanks are collected in much the same way as in the pumping method. “Clean Hands/ Dirty Hands” techniques are used. The syringe is taken out of the double bags, deionized water is aspirated into the syringe, syringe is rinsed five times with ambient water, the filter is attached, and the blank water is extruded into a sample bottle. A minimum of one blank per trip is taken, if required.

Grab Method. Bottles full of deionized water or Milli-Q are opened at the site for the same length of time the sample bottles are open.

COMPANION SAMPLES FOR METALS-IN-WATER

A hardness analysis should be requested by the Regional Water Control Board whenever metals-in-water are to be analyzed from an inland (freshwater) site. Estuarine/marine sites do not require hardness analysis.
If a total metals sample is collected, it is recommended to submit a sample for total suspended solids/suspended sediment concentration (TSS/SSC) in a companion sample for "conventionals in water".

Hexavalent Chromium

Very rarely, a request may be made for conducting hexavalent chromium analysis in water samples. Acidification alters the hexavalent form of chromium. A separate (un-acidified) sample must be submitted if hexavalent chromium is to be analyzed. Filter and submit a minimum of 500 mL water. The sample is collected in a DI-water-rinsed polyethylene or glass container, placed on ice, and shipped to the lab in time for analysis to begin within 24 h of collection. The lab must be notified when a hexavalent chromium sample will arrive. Hexavalent chromium is not usually analyzed on unfiltered samples.

FIELD QC SAMPLE COLLECTION REQUIREMENTS FOR METALS-IN-WATER

In order to assess contamination, "blanks" are submitted for analysis. Special projects may have other requirements for blanks. The same group of metals requested for the ambient samples are requested for the blank(s). Run a blank for each type of metal sample collected. Blanks results are evaluated (as soon as available) along with the ambient sample results to determine if there was contamination or not. See the Quality Control and Sample Handling Guidelines for Inorganic Analytes for information regarding frequency and types of field QC samples.

Field Equipment Blank (Ambient Blank)	Submit an equal volume (equal to the ambient sample) of metals-free deionized water that has been treated exactly as the sample at the same location and during the same time period. Use the same methods as described above (Grab sample, pumping method, syringe method). At least one ambient blank per field trip is required each for trace metal and Mercury samples in water. *If contamination is detected in field equipment blanks, blanks are required for every metals-in-water sample until the problem is resolved.*

Laboratory Equipment Blank	Laboratory Equipment Blanks for pumping and sampling equipment (Metals-in-Water Sample Collection Kits and Syringe Filtration Kits) are run by the laboratory that cleans and distributes the collection materials. It documents that the materials provided by the laboratory are free of contamination. When each batch of tubes, filters, bottles, acid and deionized water are prepared for a sampling trip, about five percent of the Mercury sampling materials are chosen for QC checks. Trace metal equipment needs to be subjected to an initial blank testing series. If these blanks are acceptable only occasional re-testing is required for TM equipment. The QC checks are accomplished by analyzing metals-free water which has been pumped through the filter and tube; collected in a sample container; and preserved.
Field Duplicates	Five percent Field Duplicates are submitted every year. (If fewer than 20 samples are collected during an event, submit one set of duplicates per event.)

Collection of Water Samples for Analysis of Synthetic Organic Compounds

Collect organic samples at a depth of 0.1 m by submerging the sample container by hand. If depth-integrated sampling is required, use the in-line peristaltic pump methodology described previously. Since organic compounds tend to concentrate on the surface of the sampling device or container, the sampling device and sample container are ***not*** to be rinsed with ambient water before being filled.

Sample Containers and Collection

Also refer the Quality Control and Sample Handling Guidelines for Synthetic Organic Compounds in Fresh and Marine Water for a list of recommended container types.

Pesticides/ Herbicides	The sample container for pesticides and herbicides is a new, clean, unused amber glass jar with a Teflon-liner inside the cap. Collect one liter of water for each of the three sample types (Organophosphorus Pesticides, Organochlorine Pesticides and Chlorinated Herbicides). **EACH ANALYSIS TYPE REQUIRES A SEPARATE JAR**. Minimize the air space in the top of the jar. Preserve immediately after collection by placing on ice out of the sunlight.
Semi-volatile Organics	The sample container for semi-volatile organics must also be new, clean, unused amber glass bottles with a Teflon-liner inside the cap, and pre-rinsed with pesticide-grade hexane, acetone, or methylene chloride. Fill jars to the top and place on ice in the dark. In addition to other sample information, label the jar Semi-volatiles.
Volatile Organics: **Volatile Organic Carbon (VOC), Methyl-Tert Butyl Ether (MTBE) and (BTEX)**	The sample containers for volatiles are VOA vials. Fill the 40-mL VOA vials to the top and cap without trapping any air bubbles. If possible, collect directly from the water, keeping the vial under water during the entire collection process. To keep the vial full while reducing the chance for air bubbles, cap the vials under the water surface. Fill one vial at a time and preserve on ice. The vials are submitted as a set. If the vial has been pre-acidified for preservation, fill the vial quickly, without shaking using a separate clean glass jar. Fill the vial till the surface tension builds a meniscus, which extends over the top end of the vial, then cap tightly and check for bubbles by turning the vial on its head. Ensure that the pH is less than 2. If the water may be alkaline or have a significant buffering capacity, or if there is concern that pre-acidified samples may have the acid wash out, take a few practice vials to test with pH paper. It may take more than two

	drops, and it will then be known how to preserve the other samples that are being submitted to the lab. If an alternative method has proven successful, continue with that method. **Note**: If vigorous foaming is observed following acidification, discard that sample and collect another set. Do not acidify the second set. Mark the sample clearly “not acidified” and the lab will run them immediately. Holding time is 14 days with acid, 7 days without acid. Collect three VOA vials, if VOC, MTBE and BTEX are required, two vials, if only VOC is required and two vials, if only MTBE and BTEX are require. The vials may be taped together to keep them together.
Perchlorate	Surface water samples for perchlorate should be collected in a new unused polyethylene or glass container. Perchlorate samples should be placed immediately on ice to maintain temperature at 6 ^{o}C. The sample holding time is 28 days, under refrigeration.
Sample Treatment in Presence of Chlorine	If in stream chlorine residual is suspected, measure the chlorine residual using a separate water subsample. Free chlorine will oxidize organic compounds in the water sample even after it is collected. If chlorine residual is above a detectable level, (i.e., the pink color is observed upon adding the reagents) immediately add 100 mg of sodium thiosulfate to the pesticides, herbicides, semi-volatiles and VOA samples; invert until sodium thiosulfate is dissolved. Record the chlorine residual concentration in field logbook. If chlorine residual is below detectable levels, no further sample treatment necessary.
VOA Trip Blank	Submit one Trip Blank for VOA samples (2- 40 mL VOA vials) for each sampling event. Trip Blanks are prepared in advance just before the sampling trip and transported to the field. Ask the laboratory for DI water and specify that it is for a VOA trip blank. VOA blanks require special purged water. Trip blanks demonstrate that the containers and sample handling did not introduce contamination. The trip blank vials are never opened during the trip.
Field QC Samples	If required, field Duplicates and field blanks are submitted at a rate subject to the discretion of the project manager. Refer to the SWAMP Quality Control and Sample Handling Guidelines for details on required blanks and duplicates.

BACTERIA AND PATHOGENS IN WATER SAMPLES

Summary of Collection Procedure (Based on EPA water quality monitoring procedures)

Make sure the containers are sterilized; either factory-sealed or labeled.

Whirl-pak® bags

- Label the bottle as previously described for SWAMP.
- Tear off the top of the bag along the perforation above the wire tab just prior to sampling. Avoid touching the inside of the bag. If you accidentally touch the inside of the bag, use another one.
- If wading into the stream, try to disturb as little bottom sediment as possible. Be careful not to collect water that has sediment from bottom disturbance. Stand facing upstream. Collect the water sample on your upstream side, in front of you.
- If taking sample from a boat, carefully reach over the side and collect the water sample on the upstream side of the boat.
- Hold the two white pull-tabs in each hand and lower the bag into the water on your upstream side with the opening facing upstream. Open the bag midway between the surface and the bottom by pulling the white pull-tabs. The bag should begin to fill with water. You may need to "scoop" water into the bag by drawing it through the water upstream and away from you. Fill the bag no more than 3/4 full.
- Lift the bag out of the water. Pour out excess water. Pull on the wire tabs to close the bag. Continue holding the wire tabs and flip the bag over at least 4-5 times quickly to seal the bag. Don't try to squeeze the air out of the top of the bag. Fold the ends of the wire tabs together at the top of the bag, being careful not to puncture the bag. Twist them together, forming a loop.
- If the samples are to be analyzed in the lab, place them in a cooler with ice or cold packs for transport to the lab.

Screw cap containers

- Label the bottle as previously described for SWAMP.
- Remove the plastic seal from the bottle’s cap just before sampling. Avoid touching the inside of the bottle or cap. If you accidentally touch the inside, use another bottle.

- If wading into the stream, try to disturb as little bottom sediment as possible. Be careful not to collect water that has sediment from bottom disturbance. Stand facing upstream. Collect the water sample on your upstream side, in front of you.
- If taking sample from a boat, carefully reach over the side and collect the water sample on the upstream side of the boat.
- Hold the bottle near its base with polyethylene gloves and submerge the bottle in the water with the cap on. Open the bottle collecting the water sample 0.1m beneath the surface. When the bottle is filled to the desired level recap the bottle and remove from water. You can only use this method if the sample bottles do not contain sodium thiosulfate.
- Turn the bottle underwater into the current and away from you. In slow moving stream reaches, push the bottle underneath the surface and away from you in an upstream direction.
- Alternative sampling method: In case the sample bottle contains preservatives/chlorine removers (i.e. Sodium-Thiosulfate), it cannot be plunged opening down. In this case hold the bottle upright under the surface while it is still capped. Open the lid carefully just a little to let water run in. Fill the bottle to the fill mark and screw the lid tight while the bottle is still underneath the surface.
- Leave a 1-in. air space so that the sample can be shaken just before analysis. Recap the bottle carefully, remembering not to touch the inside.
- If the samples are to be analyzed in the lab, place them in a cooler with ice or cold packs for transport to the lab. Samples should be placed immediately on ice to maintain temperature at 6 ^{o}C

Pouring from another clean bottle

- Due to different sampling conditions (high turbidity, rough water etc.) it is sometimes easy to pour water from another clean bottle into the bacteria bottle. This helps to make sure that the sample water is only being filled to the desired line and no overfilling occurs.

TOXICITY IN WATER

Sample Collection

Using the standard grab sample collection method described previously for water samples, fill (for typical suite of water toxicity tests conducted) the required amount of 2.25-L amber glass bottles with sub surface water. Since the size of the 2.25-L amber bottle is bigger than your average sample bottle, find a spot in the centroid of the stream to completely submerge the toxicity bottle if possible. A clean water organics(1-L glass amber) bottle can be used if there is no sampling point deep enough to submerge a large toxicity bottle. If the stream is not deep enough to submerge any bottle, then comments should be made on the field data sheets that surface water was collected. Depth should also equal 0 for the sampling depth. All toxicity samples should be. put on ice, and cooled to 4 °C. Label the containers as described above and notify the laboratory of the impending sample delivery, since there is a 48-hr maximum sample hold time. Sample collection must be coordinated with the laboratory to guarantee appropriate scheduling.

Summary of Sample Container, Volume, Initial Preservation, and Holding Time Recommendations for Water Samples

Parameters for Analysis in WATER Samples	**Recommended Containers (all containers pre-cleaned)**	**Typical Sample Volume (mL)**	**Initial Field Preservation**	**Maximum Holding Time (analysis must start by end of max)**
Conventional Constituents in Water				
Alkalinity	Polyethylene bottles (see **NOTE**$^{(1)}$ below)	950 mL	Cool to ≤ 6 °C, dark	14 days at ≤ 6 °C, dark
Chloride (Cl), Sulfate (SO_4) and Fluoride (F)	Polyethylene bottles (see **NOTE**$^{(1)}$ below)	950 mL	Cool to ≤ 6 °C, dark	28 days at ≤ 6 °C, dark
Ortho-phosphate (OPO_4)	Field filtered during collection into a 125 mL polyethylene bottle	60 mL	Filter within 15 minutes; Cool to ≤ 6 °C, dark	48 h at ≤ 6 °C, dark
Nitrate + Nitrite (00630) (NO_3 + NO_2)	Clear polyethylene 500 mL with 0.4mL concentrate H_2SO_4 Preservative.	500 mL	Cool to ≤ 6 °C, dark	48 h at ≤ 6 °C, dark
Total Keldjahl Nitrogen (TKN)	Clear polyethylene 500 mL with 0.4mL concentrate H_2SO_4 Preservative.	500 mL	Cool to ≤ 6 °C, dark; H_2SO_4 to pH<2	Unacidified: 7 days Acidified: 28 days Either one at ≤ 6 °C, dark
Total Dissolved Solids (TDS)	Polyethylene bottles (see **NOTE**$^{(1)}$ below)	950 mL	Cool to ≤ 6 °C, dark Cool to 4°C, dark	7 days at ≤ 6 °C, dark
Ammonia (NH_3)	Clear polyethylene 500 mL with 0.4mL concentrate H_2SO_4 Preservative.	500 mL	Cool to ≤6˚C; samples may be preserved with 2 mL of H_2SO_4 per L	Unacidified: 48 h Acidified: 28 days Either one at ≤ 6 °C, dark
Total Phosphorus (TPO_4) and Total Nitrogen (TN)	Clear polyethylene 500 mL with 0.4mL concentrate H_2SO_4 Preservative.	500 mL	Cool to ≤ 6 °C, dark	Unacidified: 48 h Acidified: 28 days Either one at ≤ 6 °C, dark
(1)NOTE: The volume of water necessary to collect in order to analyze for the above constituents is typically combined in 1 950mL polyethylene bottle. More water volume might be needed for possible re-analysis and for conducting lab spike duplicates. This is possible since the same laboratory is conducting all of the above analyses; otherwise, individual volumes apply.				
Total Organic Carbon (TOC), **Dissolved Organic Carbon (DOC)**	125 mL amber glass PC with 1ml 1:1 H_2SO_4 preservative. Field filtered 125 mL amber glass PC with 1ml 1:1 H_2SO_4 preservative.	125 mL for TOC 125 mL for DOC	Cool to ≤6 ◦C; acidify to pH<2 with HCl, H_3PO_4, or H_2SO_4 within 2 hrs Filter and preserve to pH<2 within 48 hours of collection; cool to ≤6˚C	28 days 28 days
Total Suspended Solids (TSS)	Clear HDPE 2000 mL narrow mouth bottle	2000 mL	Cool to ≤6˚C, dark	7 days at ≤6˚C, dark
Suspended Sediment Concentration (SSC)	Amber 950 mL HDPE wide mouth bottle.	Up to 950 ml depending on turbidity of water	Cool to ≤6˚C, dark	7 days at ≤6˚C, dark

Parameters for Analysis in WATER Samples	Recommended Containers (all containers pre-cleaned)	Typical Sample Volume (mL)	Initial Field Preservation	Maximum Holding Time (analysis must start by end of max)
Chlorophyll *a* **Pheophytin *a*** **Chlorophyll a** **Pheophytin *a***	1-L amber polyethylene bottle Aluminum Foil, GFC Filters	1000 mL (one bottle) 20-420 mL	Centrifuge or filter as soon as possible after collection; if processing must be delayed, keep samples on ice or at ≤6˚C; store in the dark	Samples must be frozen or analyzed within 4 hours of collection; filters can be stored frozen for 28 days
Non-Routine Compounds in Water Samples				
OIL AND GREASE	1-L glass jar with Teflon lid-liner, rinsed with hexane or methylene chloride	1000 mL (one jar)	Cool to ≤6˚C; HNO_3 or H_2SO_4 to pH<2	28 days at ≤6˚C, dark
PHENOLS	1-L glass jar with Teflon lid-liner	1000 mL (one jar)	Cool to ≤6˚C; H_2SO_4 to pH<2	28 days at ≤6˚C, dark
CYANIDE	1-L cubitainer	1000 mL (one cubitainer)	Cool to ≤6˚C; NaOH to pH>10; add 0.6 g $C_6H_8O_6$ if residual chlorine is present	14 days at ≤6˚C, dark
BIOCHEMICAL OXYGEN DEMAND (BOD)	4-L cubitainer	4000 mL (one cubitainer)	Cool to ≤6˚C; add 1 g FAS crystals per liter if residual chlorine is present	48 h at ≤6˚C, dark
CHEMICAL OXYGEN DEMAND (COD)	1-L cubitainer	110 mL (one cubitainer)	Cool to ≤6˚C; H_2SO_4 to pH<2	28 days at ≤6˚C, dark; biologically active samples should be tested as soon as possible
Trace Metals in Water Samples				
DISSOLVED METALS (except Dissolved Mercury)	60 mL polyethylene bottle, pre-cleaned in lab using HNO_3	60 mL (one bottle)	Filter at sample site using 0.45 micron in-line filter, or syringe filter (within 15 minutes of collection). Cool to 6°C, dark. Acidify in lab, within 48 hrs, using pre-acidified container (ultra-pure HNO_3) for pH<2.	Once sample is filtered and acidified, can store up to 6 months at room temperature

Parameters for Analysis in WATER Samples	**Recommended Containers (all containers pre-cleaned)**	**Typical Sample Volume (mL)**	**Initial Field Preservation**	**Maximum Holding Time (analysis must start by end of max)**
DISSOLVED MERCURY	250 mL glass or Teflon bottle, pre-cleaned in lab using HNO_3	250 mL (one bottle)	Filter within 15 minutes of collection. Cool to 6°C, dark. Acidify in lab within 48 hrs, with pre-tested HCL to 0.5%.	Once sample is filtered and acidified, can store up to 90 days at room temperature
TOTAL METALS (except Total Mercury)	60 mL polyethylene bottle, pre-cleaned in lab using HNO_3	60 mL (one bottle)	Cool to ≤6˚C, dark. Acidify in lab within 48 hrs, with pre-acidified container (ultra-pure HNO_3), for pH<2.	Once sample is acidified, can store up to 6 months at room temperature
TOTAL MERCURY	250 mL glass or Teflon bottle, pre-cleaned in lab using HNO_3	250 mL (one bottle)	Cool to ≤6˚C, dark. Acidify in lab within 48 hrs, with pre-tested HCL to 0.5%.	Once sample is acidified, can store up to 90 days at room temperature.
HEXAVALENT CHROMIUM (filtered)	600 mL plastic or glass bottle	600 mL (one bottle)	Cool to ≤6˚C, dark No acid	Keep at ≤6˚C, dark for up to 24 h; must notify lab in advance.
HARDNESS	200 mL polyethylene bottle	200 mL (one bottle)	Cool to 6°C, dark OR Cool to ≤6˚C; HNO_3 or H_2SO_4 to pH<2	48 h at 6°C, dark 6 months at ≤6˚C, dark
Synthetic Organic Compounds in Water Samples				
VOLATILE ORGANIC ANALYTES (VOA's) including VOC, MTBE and BTEX	40 mL VOA vials	120 mL (three VOA vials)	All vials are pre-acidified (50% HCl or H_2SO_4) at lab before sampling. Cool to 6°C, dark	unacidified: 7 days acidified: 14 days Both at 6°C, dark
PESTICIDES & HERBICIDES* ☐Organophosphate Pesticides ☐Organochlorine Pesticides ☐Chlorinated Herbicides **SEMI-VOLATILE ORGANICS*** **POLYCHLORINATED* BIPHEYNYL AND AROCHLOR COMPOUNDS** **TPH, PAH, PCP/TCP***	1-L I-Chem 200-series amber glass bottle, with Teflon lid-liner (per each sample type)	1000 mL (one container) ***Each sample type requires 1000 mL in a separate container**	Cool to 6°C, dark If chlorine is present, add 0.1g sodium thiosulfate	Keep at 6°C, dark, up to 7 days. Extraction must be performed within the 7 days; analysis must be conducted within 40 days.

Parameters for Analysis in WATER Samples	**Recommended Containers (all containers pre-cleaned)**	**Typical Sample Volume (mL)**	**Initial Field Preservation**	**Maximum Holding Time (analysis must start by end of max)**
Toxicity Testing Water Samples				
TOXICITY IN WATER	Four 2.25 L amber glass bottles	9000 mL	Cool to 4°C, dark	48 hrs at 4°C, dark
Bacteria and Pathogens in Water Samples				
E. Coli	Factory-sealed, pre-sterilized, disposable Whirl-pak® bags or 125 mL sterile plastic (high density polyethylene or polypropylene) container	100 mL volume sufficient for both E. coli and Enterococcus analyses	Sodium thiosulfate is pre-added to the containers in the laboratory (chlorine elimination). Cool to ≤ 10°C; dark.	STAT: 8 hrs at ≤ 10°C, dark if data for regulatory purposes; otherwise, 24 hrs at ≤ 10°C, dark if non-regulatory purpose.
Enterococcus	Factory-sealed, pre-sterilized, disposable Whirl-pak® bags or 125 mL sterile plastic (high density polyethylene or polypropylene) container	100 mL volume sufficient for both E. coli and Enterococcus analyses	Sodium thiosulfate is pre-added to the containers in the laboratory (chlorine elimination). Cool to ≤ 10°C ; dark.	STAT: 8 hrs at ≤ 10°C, dark if data for regulatory purposes; otherwise, 24 hrs at ≤ 10°C, dark if non-regulatory purpose.
FECAL COLIFORM	Factory-sealed, pre-sterilized, disposable Whirl-pak® bags or 125 mL sterile plastic (high density polyethylene or polypropylene) container	100 mL volume sufficient for both fecal and total coliform analyses	Sodium thiosulfate is pre-added to the containers in the laboratory (chlorine elimination). Cool to ≤ 10°C; dark.	STAT: 8 hrs at ≤ 10°C, dark if data for regulatory purposes; otherwise, 24 hrs at ≤ 10°C, dark if non-regulatory purpose.
TOTAL COLIFORM	Factory-sealed, pre-sterilized, disposable Whirl-pak® bags or 125 mL sterile plastic (high density polyethylene or polypropylene) container	100 mL volume sufficient for both fecal and total coliform analyses	Sodium thiosulfate is pre-added to the containers in the laboratory (chlorine elimination). Cool to ≤ 10°C; dark.	STAT: 8 hrs at ≤ 10°C, dark if data for regulatory purposes; otherwise, 24 hrs at ≤ 10°C, dark if non-regulatory purpose.

Field Collection Procedures for Bed Sediment Samples

Bed sediment (hereafter termed "sediment") samples are collected after any water samples are collected where water and sediment are taken in the same reach. Care must be taken not to sample sediments that have been walked on or disturbed in any manner by field personnel collecting water samples. Sediment samples are collected into a composite jar, where they are thoroughly homogenized in the field, and then aliquoted into separate jars for chemical or toxicological analysis. Sediment samples for metals and organics are submitted to the respective analytical laboratories in separate glass jars, which have been pre-cleaned according to laboratory protocol.

Sediment chemistry samples give information regarding both trends in contaminant loading and the potential for adverse effects on sediment and aquatic biota. In order to compare samples over time and from site to site, they must be collected in a consistent manner. Recently deposited fine grain sediments (see attached table) are the target for sediment collection. If a suitable site for collecting sediments cannot be found at a station (it only contains larger grain material), sampling personnel should not collect the sediment sample, and should instead attempt to reschedule the sample collection or move to a different area that has more recently deposited fine sediment. If this is not possible, make a note so that the missing sample is accounted for in the reconciliation of monitoring events during preparation of sample collection "cruise reports". Sites that are routinely difficult to collect should be considered for elimination or relocation from the sample schedule, if appropriate.

Characteristics of Ideal Sediment Material to be Collected	Many of the chemical constituents of concern are adsorbed onto fine particles. One of the major objectives in selecting a sample site, and in actually collecting the sample while on site, is to obtain recently deposited fine sediment, to the extent possible. Avoid hard clay, bank deposits, gravel, disturbed and/or filled areas. Any sediment that resists being scooped by a dredge is probably not recently deposited fine sediment material. In following this guidance, the collection of sediment is purposefully being biased for fine materials, which must be discussed thoroughly in any subsequent interpretive reporting of the data, in regards to representation of the collected sample to the environment from which it was collected.
Characteristics of an Ideal Site	Quiescent areas are conducive to the settling of finer materials (EPA/USACOE, 1981). Choose a sampling site with lower hydrologic energy, such as the inner (depositional) side of bends or eddies where the water movement may be slower. Reservoirs and estuaries are generally

depositional environments, also.

Selecting the Appropriate Sediment Type for Analysis

Sediment will vary from site to site and can vary between sample events at a particular site.

Streams and Rivers: Sediment collection in flowing streams is often a challenge. In areas of frequent scouring there may not be sufficient sediment for collection during or following periods of high flow. Sediment collection during these times may prove unsuccessful and may have to be rescheduled or cancelled.

When the suspended load in rivers and streams precipitates due to reduction of velocity, most of the resulting sediment will be fine-grained. More often than not, a dredge or mechanical grab device does not function well for collection of sediment in smaller streams. In many cases, sediment will have to be collected using a pre-cleaned polyethylene scoop. Collect the top 2 cm for analysis. Five or more (depending on the volume of sediment needed for conducting analyses) fine-sediment sub-sites within a 100-m reach are sampled into the composite jar.

Reservoirs and Estuaries: Collect the top 2 cm for analysis. Grabs are composited for the sediment sample, depending on the volume of sediment needed for conducting analyses.

GENERAL PROCEDURE FOR COLLECTION OF BED SEDIMENT

After choosing an appropriate site, and identifying appropriate fine-grained sediment areas within the general reach, collect the sample using one or more of the following procedures, depending on the setting:

A. Sediment Scoop Method—Primary Method for Wadeable, Shallow Streams

- The goal is to collect the top 2 cm of recently-deposited fine sediment only.
- Wear gloves and protective gear, in areas of potential exposure hazards, per appropriate protocol (make sure gloves are long enough to prevent water from overflowing gloves while submerging scoop).
- Survey the sampling area for appropriate fine-sediment depositional areas before stepping into the stream, to avoid disturbing possible sediment collection sub-sites.
- Carefully enter the stream and start sampling at the closest appropriate reach, then continue sampling UPSTREAM. Never advance downstream, as this could lead to sampling

disturbed sediment.

- Stir, do not shake, collected sediment with a polyethylene scoop for at least 5 min making sure all sediment is completely homogenized.
- Quickly scoop sediment out of the homogenizing jar into desired sampling jars making sure to stir the sediment in the homogenizing jar in between each aliquot.
- Inspect each individual sediment jar making sure of consistent grain size throughout the entire sample collection.
- Single bag all sediment containers to prevent cross contamination.
- Make sure all containers are capped tightly and stored in a cooler on cube ice at 6 °C.

B. <u>Hand Core Method-Alternate method for wadeable shallow streams with fine sediment</u>

- A hand core is used in wadeable streams where there is very fine sediment.
- The hand core sampler consists of a 3-in. diameter polycarbonate core that is 8 inches long. Samplers push the core into the sediment to the desired depth, pull the core out of the sediment, and cap the bottom with a polyethylene core cap or by placing their hand underneath the cap to hold the sediment in place.
- Hand cores are usually measured and marked at 2 cm length so the sampler knows how far to deploy the core into the sediment.
- Sediment is then emptied into a homogenizing jug and aliquoted accordingly.

C. <u>Sediment Grab Method—Primarily for Lake, River, Bridge, and Estuarine Settings (or deeper streams)</u>

Description of sediment grab equipment:

- A mechanical sediment grab is used for the SWAMP bed sediment collection field effort for lake, river, bridge, and estuarine/coastal settings (or deeper, non-wadeable streams).
- The mechanical grab is a stainless steel “Young-modified Van Veen Grab", and is 0.5 m^2 in size.
- The mechanical grab is deployed primarily from a boat, and is used in deeper, non-wadeable waters, such as lakes, rivers, estuaries, and coastal areas.
- It is also deployed by field personnel from land in settings which allow its use: primarily from bridges; from smaller vessels in streams or drainage channels too deep or steep to wade into, but too shallow for a larger boat.

Deploying and retrieving the grab:

- Slowly lower the grab to the bottom with a minimum of substrate disturbance.
- Retrieve the closed dredge at a moderate speed (e.g., less than two feet per second).
- Upon retrieval, open the lids of the sediment grab, examine the sample to ensure that the

sediment surface is undisturbed and that the grab sample should not be rejected.

Rejection Criteria—reject the sample if the following are not met:

- Mud surface must not be pressing out of the top of the sampler. If it is, lower the grab more slowly.
- Overlying water must not be leaking out along the sides of the sediment in the grab. This ensures the surficial sediment is not washed out.
- Sediment surface is flat and level in the sampler. If it is not level, the grab has tilted over before closing.

Processing the sediment sample from the grab equipment:

- The water overlying the sediment in the grab is very gently decanted by slightly tipping the grab with the lid closed until the water runs out the top.
- The decanting process should remove all of the overlying water but not remove the surficial sediments. The laboratory reports percent water for the sample, so overlying water is not included in the sample container.
- The sediment is examined for depth of penetration, color and thickness of top aerobic zone, and texture. These observations are recorded on the field data sheet.
- Collect the top 2 cm from at least five sub samples, and otherwise, exclude the bottom-most layer and composite.
- In streams or other settings with excessive bottom debris (e.g., rocks, sticks, leaves) where the use of a grab is determined to be ineffective (e.g., dredge does not close, causing loss of sediment), samples may be collected by hand using a clean plastic scoop, or by a variety of coring methods, if appropriate for the situation.
- Sediment is handled as described below in the metals and organic sections.

Cleaning the Grab Equipment and Protection from Potential Contaminating Sources:

- The sediment sampler will be cleaned prior to sampling EACH site by: rinsing all surfaces with ambient water, scrubbing all sediment sample contact surfaces with Micro™ or equivalent detergent, rinsing all surfaces with ambient water, rinsing sediment sample contact surfaces with 5% HCl, and rinsing all sediment sample contact surfaces with methanol.
- The sediment grab will be scrubbed with ambient water between successive deployments at ONE site, in order to remove adhering sediments from contact surfaces possibly originating below the sampled layer, thus preventing contamination from areas beyond target sampling area.
- Sampling procedures will attempt to avoid exhaust from any engine aboard any vessel involved in sample collection. An engine will be turned off when possible during portions of the sampling process where contamination from engine exhaust may occur. It is critical that sample contamination be avoided during sample collection. All sampling equipment (e.g., siphon hoses, scoops, containers) will be made of non-contaminating material and will be appropriately cleaned before use. Samples will not be touched with un-gloved fingers. In addition, potential airborne contamination (e.g., from engine exhaust, cigarette smoke) will be avoided.

D. Core Method--alternative for fast-moving, wadeable streams

The core method is used in soft sediments when it is difficult to use the other methodologies. The cores can be used in depths of water from 0 to 10 ft by using a pole deployment device or in deeper water using SCUBA divers. The pole deployment device consists of a pole that attaches to the top of the core. The top of the core is fitted with a one-way valve, which allows the core to be filled with sediment, but when pulled from the sediment catches the sediment within the core. The core is then brought to the surface and the sediments within the core are extruded out the top of the core so that 2 cm of sediment is above the top of the plastic core. The 2 cm of sediment is then sliced off and placed in the homogenizing jar. A new core, homogenizing jar, and device used to slice off the top two cm. are used at each station unless the equipment is cleaned using laboratory protocols.

E. Sediment Grab Method – Primarily used from bridges or for streams with restricted bank access.

Description and sampling procedure for the Eckman sediment grab

- The Eckman grab is 0.2 m^2 in size with a lead "messenger" that triggers the spring loaded doors.
- The primary use is for sampling from bridges or from small vessels in streams or drainage channels too deep or steep to wade into, but too shallow for a larger boat.
- The grab must be cleaned with a Micro™ and tap water rinse before sampling and in-between sample stations.
- To deploy the grab, pull the spring loaded doors open and hook the cables on the actuator plate.
- With a rope, lower the grab to the desired sample reach making sure that the grab has penetrated the sediment. Clip the "messenger" on the rope and release it while maintaining tension on the rope. Pull up the grab once the "messenger" has activated the doors.
- While wearing clean poly gloves, open the top hatch and remove the top 2 cm of sediment with a clean polyethylene scoop. Place the sediment into the homogenizing jug and repeat the sampling process until there is enough desired sediment. See general procedures for processing of bed sediment samples, once they are collected for sediment homogenization and aliquoting into sample jars.

GENERAL PROCEDURE FOR PROCESSING OF BED SEDIMENT SAMPLES, ONCE THEY ARE COLLECTED

Sediment Homogenization, Aliquoting and Transport

For the collection of bed sediment samples, the top 2 cm is removed from the scoop, or the grab, or the core, and placed in the 4-L glass compositing/homogenizing container. The composited sediment in the container is homogenized and aliquoted on-site in the field. The sample is stirred with a polyethylene scoop until sediment/mud appears homogeneous. All sample identification information (station numbers, etc.) will be recorded prior to homogenizing and aliquoting. Sediment samples will immediately then be cooled to 6 °□C and separated for preservation according to the: Summary of Sample Container, Volume, Preservation, and Storage Requirements for SWAMP Bed Sediment, Biota, and Tissue Samples (for contaminant analysis).Each container will be sealed in one large plastic bag to prevent contact with other samples or ice or water.

Metals and Semi-volatile Organics in Sediment	For trace metals and semi-volatile organics, a minimum of three grabs is distributed to the composite bottle and/or sample containers. Mixing is generally done with a polyethylene scoop. Make sure the sample volume is adequate, but the containers do not need to be filled to the top. Seal the jars with the Teflon liner in the lids.
Sediment Conventionals	Sediment conventionals are sometimes requested when sediment organics, sediment metals, and/or sediment toxicity tests are requested for analysis of samples. The collection method is the same as that for metals, semi-volatile organics, and pesticides. Sediment conventionals include: grain size analysis and total organic carbon. These are used in the interpretation of metals and organics in sediment data.
Sample Containers	See “Sediment Sample Handling Requirements” table at end of this document.
Sediment Sample Size	Must collect sufficient volume of sediment to allow for proper analysis, including possible repeats, as well as any requested archiving of samples for possible later analysis. See “Sediment Sample Handling Requirements” Table at end of this document.
Labeling	Label the jars with the station ID, sample code, matrix type, project ID, time, and date of collection, as well as the type of analysis requested (e.g., metals, conventionals, organics, or archives).
Short-term Field Preservation	Immediately place the labeled jar on ice, cool to 6 °□C, and keep in the dark at 4 °□C until delivery to the laboratory.
Field Notes	Fill out the SWAMP Sediment Data Sheet. Make sure to record any field notes that are not listed on the provided data sheets. This information can be reported as comments with the sediment analytical results.

Summary of Sample Container, Volume, Preservation, and Storage Requirements for SWAMP Bed Sediment, Biota, and Tissue Samples (for contaminant analysis)

Parameters for Analysis	**Recommended Containers**	**Typical Sample Volume (mL)**	**Initial Field Preservation**	**Maximum Holding Time**
Bed Sediment Samples				
Trace Metals, including Hg and As (except for Se--see below)	60-mL I-Chem 300- series clear glass jar with Teflon lid-liner; Pre-cleaned	60 mL (one jar)	Cool to ≤6 °C within 24 hours, then freeze to ≤-20 °C	12 months(1) (-20 °C)
Methylmercury	60-mL I-Chem 300- series clear glass jar with Teflon lid-liner; Pre-cleaned	60 mL (one jar)	Freeze to ≤-20 °C immediately	12 months(1) (-20 °C)
Selenium (separate container required)	60-mL I-Chem 300- series clear glass jar with Teflon lid-liner; Pre-cleaned	60 mL (one jar)	Cool to ≤6 °C within 24 hours, then freeze to ≤-20 °C	12 months(1) (-20 °C)
Synthetic Organic Compounds	250-mL I-Chem 300-series amber glass jar with Teflon lid-liner; Pre-cleaned	500 mL (two jars)	Cool to ≤6 °C within 24 hours, then freeze to ≤-20 °C	12 months(1) (-20 °C)
Sediment TOC	250-mL(3) clear glass jar; Pre-cleaned	125 mL (one jar)	Cool to ≤6 ˚C or freeze to ≤-20 ˚C	28 days at ≤6 ˚C; 1 year at ≤-20 ˚C (2)
Sediment Grain Size	250-mL(3) clear glass jar; Pre-cleaned	125 mL (one jar)	Wet ice to ≤6 ˚C in the field, then refrigerate at ≤6 ˚C	1 year (≤6 ˚C) ***<u>Do not freeze</u>***
Sediment Toxicity Testing	1-L I-Chem wide-mouth polyethylene jar with Teflon lid-liner; Pre-cleaned	2 (two jars filled completely)	Cool to 4 °C, dark, up to 14 days	14 days (4 °C) ***<u>Do not freeze</u>***

(1) Sediment samples for parameters noted with one asterisk (*) may be refrigerated at 6 °C for up to 14 days maximum, but analysis <u>must</u> start within the 14-day period of collection or thawing, or the sediment sample <u>must</u> be stored frozen at minus (-) 20 °C for up to 12 months.

(2) Sediment samples for sediment TOC analysis can be held at 4°C for up to 28 days, and <u>should</u> be analyzed within this 28-day period, but can be frozen at any time during the initial 28 days, for up to 12 months at minus (-) 20 °C.

(3) Sediment samples for TOC AND grain size analysis can be combined in one 250 mL clear glass jar, and sub-sampled at the laboratory in order to utilize holding time differences for the two analyses. If this is done, the 250 mL combined sediment sample must be refrigerated only (<u>not frozen</u>) at 4 °C for up to 28 days, during which time the sub-samples must be aliquoted in order to comply with separate storage requirements (as shown above).

APPENDIX G:

STATE WATER QUALITY CONTROL PLAN FOR ENCLOSED BAYS AND ESTUARIES – PART 1 SEDIMENT QUALITY (SQO – PART 1)

CALIFORNIA
Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

WATER QUALITY CONTROL PLAN FOR ENCLOSED BAYS AND ESTUARIES
- PART 1 SEDIMENT QUALITY

Effective August 25, 2009

STATE WATER RESOURCES CONTROL BOARD

California Environmental Protection Agency

State of California
Arnold Schwarzenegger, Governor

California Environmental Protection Agency
Linda S. Adams, Secretary

State Water Resources Control Board
http://www.waterboards.ca.gov

History of Plan
Adopted by the State Water Resources Control Board on September 16, 2008
Approved by the Office of Administrative Law on January 5, 2009
Approved by the U. S. Environmental Protection Agency on August 25, 2009

Prepared by
Chris Beegan, Ocean Unit, Division of Water Quality

STATE WATER RESOURCES CONTROL BOARD
RESOLUTION NO. 2008-0070

ADOPTION OF A WATER QUALITY CONTROL PLAN FOR ENCLOSED BAYS AND ESTUARIES – PART 1 SEDIMENT QUALITY

WHEREAS:

1. California Water Code section 13393 requires the State Water Resources Control Board (State Water Board) to develop sediment quality objectives for toxic pollutants for California's enclosed bays and estuaries.
2. In 1991, the State Water Board adopted a workplan for the development of sediment quality objectives for California's enclosed bays and estuaries (1991 Workplan).
3. Due to funding constraints, the State Water Board did not implement the 1991 Workplan; consequently, litigation by environmental interests against the State Water Board ensued.
4. In August 2001, the Sacramento County Superior Court ruled against the state and ordered the State Water Board to initiate development of sediment quality objectives. On May 21, 2003, the State Water Board adopted a revised workplan.
5. Based upon the scope of work in the revised workplan, staff developed narrative sediment quality objectives to protect benthic communities, which utilize an approach based upon multiple lines of evidence.
6. Narrative sediment quality objectives have also been developed to protect human health from exposure to contaminants in fish tissue.
7. Staff also developed an implementation program for the narrative sediment quality objectives based upon input from the Scientific Steering Committee, Sediment Quality Advisory Committee, and staff of the State Water Board and the Regional Water Quality Control Boards (Regional Water Boards), and staff from other state and federal agencies. The work that has been completed, to date, is Phase 1 of the sediment quality objectives program.
8. The State Water Board recognizes this effort is an iterative process. Staff additionally have initiated a second phase of the sediment quality objectives program (Phase 2), which includes extensive sediment sampling in the Delta; further development of the estuarine chemistry, sediment toxicity, and benthic community indicators; and completion of a more prescriptive framework to address human health and exposure to contaminants in fish tissue. The tools, indicators, and framework developed under Phase 2 will be adopted into the draft plan in 2010. Phase 3 is proposed as the development, within available resources, of a

framework to protect fish and/or wildlife from the effects of pollutants in sediment. During Phases 2 and 3, staff would continue to evaluate the tools developed during the initial phase and the implementation language. As the Water Boards experience grows, the draft plan would be updated and amended as necessary to more effectively interpret and implement the narrative objectives.

9. In the process of developing SQOs, the State Water Board has identified the need to address statewide consistency in the regulation of dredging activities under the water quality certification program. While this issue is outside the scope of this plan, the State Water Board will consider initiating policy development in the future to address regulation of dredging activities under the water quality certification program.

10. The State Water Board's Clean Water Act section 303(d) listing policy was adopted prior to the development of SQOs and without the benefit of the scientific evidence supporting their development. The State Water Board recognizes the need to ensure that the listing policy and this plan are consistent. The State Water Board will, therefore, consider amending the 303(d) listing policy in the future to ensure consistency with this plan.

11. Staff has responded to significant verbal and written comments received from the public and made minor revisions to the draft plan in response to the comments.

12. In adopting this draft plan, the State Water Board has considered the requirements in Water Code section 13393. In particular, the sediment quality objectives are based on scientific information, including chemical monitoring, bioassays, and established modeling procedures; and the objectives provide adequate protection for the most sensitive aquatic organisms. In addition, sediment quality objectives for the protection of human health from contaminants in fish tissue are based on a health risk assessment.

13. As required by Water Code section 13393, the State Water Board has followed the procedures for adoption of water quality control plans in Water Code sections 13240 through 13247, in adopting this draft plan. In addition to the procedural requirements, the State Water Board has considered the substantive requirements in Water Code sections 13241 and 13242. The State Water Board has considered the past, present, and probable future beneficial uses of estuarine and bay waters that can be impacted by toxic pollutants in sediments; environmental characteristics of these waters; water quality conditions that can reasonably be achieved through the control of all factors affecting sediment quality; and economic considerations. Adoption of this draft plan is unlikely to affect housing needs or the development or use of recycled water. Further, the State Water Board has developed an implementation program to achieve the sediment quality objectives, which describes actions to be taken to achieve the objectives and monitoring to determine compliance with the objectives. Time schedules to achieve the objectives will be developed on a case-by-case basis by the appropriate Regional Water Board.

14. This draft plan is consistent with the state and federal antidegradation policies (State Water Board Resolution No. 68-16 and 40 C.F.R. Section 131.12, respectively). No lowering of water quality is anticipated to result from adoption of the draft plan. The draft plan contains scientifically-defensible sediment quality objectives for bays and estuaries, which can be consistently applied statewide to assess sediment quality, regulate waste discharges that can impact sediment quality, and provide the basis for appropriate remediation activities, where necessary. Adoption of the draft plan should result in improved sediment quality.

15. The Resources Agency has approved the State and Regional Water Boards' planning process as a "certified regulatory program" that adequately satisfies the California Environmental Quality Act (CEQA) requirements for preparing environmental documents. State Water Board staff has prepared a "substitute environmental document" for this project that contains the required environmental documentation under the State Water Board's CEQA regulations. (California Code of Regulations, title 23, section 3777.) The substitute environmental documents include the "Draft Staff Report – Water Quality Control Plan for Enclosed Bays and Estuaries, Part 1. Sediment Quality," the environmental checklist, the comments and responses to comments, the plan itself, and this resolution. The project is the adoption of sediment quality objectives and an implementation program, as Part 1 of the Water Quality Control Plan for Enclosed Bays and Estuaries.

16. CEQA scoping hearings were conducted on October 23, 2006 in San Diego, California, on November 8, 2006 in Oakland, California, and on November 28, 2006 in Rancho Cordova, California.

17. On September 26, 2007, staff circulated the draft plan – Part 1 Sediment Quality for public comment.

18. On November 19, 2007, the State Water Board conducted a public hearing on the draft plan and supporting Draft Staff Report and Substitute Environmental Document. Written comments were received through November 30, 2007.

19. The State Water Board adopted the Plan on February 19, 2008, and submitted it to the Office of Administrative Law (OAL) on February 29, 2008. Review by OAL revealed that the statutorily-required newspaper notification of the November 2007 hearing had not occurred. The State Water Board has, therefore, noticed and conducted a new public hearing for the draft plan on September 16, 2008.

20. In preparing the substitute environmental documents, the State Water Board has considered the requirements of Public Resources Code section 21159 and California Code of Regulations, title 14, section 15187, and intends these documents to serve as a Tier 1 environmental review. The State Water Board has considered the reasonably foreseeable consequences of adoption of the draft plan; however, project level impacts may need to be considered in any subsequent environmental analysis performed by lead agencies, pursuant to Public Resources Code section 21159.1.

21. Consistent with CEQA, the substitute environmental documents do not engage in speculation or conjecture but, rather, analyze the reasonably foreseeable environmental impacts related to methods of compliance with the draft plan, reasonably foreseeable mitigation measures to reduce those impacts, and reasonably feasible alternatives means of compliance that would avoid or reduce the identified impacts.

22. The draft plan could have a potentially significant adverse effect on the environment. However, there are feasible alternatives or feasible mitigation measures that, if employed, would reduce the potentially significant adverse impacts identified in the substitute environmental documents to less than significant levels. These alternatives or mitigation measures are within the responsibility and jurisdiction of other public agencies. When the sediment quality objectives are implemented on a project-specific basis, the agencies responsible for the project can and should incorporate the alternatives or mitigation measures into any subsequent project or project approvals.

23. From a program-level perspective, incorporation of the mitigation measures described in the substitute environmental documents will foreseeably reduce impacts to less than significant levels.

24. The substitute environmental documents for this draft plan identify broad mitigation approaches that should be considered at the project level.

25. Pursuant to Health and Safety Code section 57400, the draft Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1 Sediment Quality has undergone external peer review through an interagency agreement with the University of California.

26. This draft plan must be submitted for review and approval to the State Office of Administrative Law (OAL) and the United States Environmental Protection Agency (USEPA). The draft plan will become effective upon approval by OAL and USEPA.

27. If, during the OAL approval process, OAL determines that minor, non-substantive modifications to the language of the draft plan are needed for clarity or consistency, the Executive Director or designee may make such changes consistent with the State Water Board's intent in adopting this draft plan, and shall inform the State Water Board of any such changes.

THEREFORE BE IT RESOLVED THAT:

The State Water Board:

1. Approves and adopts the CEQA substitute environmental documentation, including all findings contained in the documentation, which was prepared in accordance with Public Resources Code section 21159 and California Code of

Regulations, Title 14, section 15187, and directs the Executive Director or designee to sign the environmental checklist;

2. After considering the entire record, including oral testimony at the public hearing, hereby adopts the proposed Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1 Sediment Quality;

3. Directs staff to submit the administrative record to OAL for review and approval; and

4. If, during the OAL approval process, OAL determines that minor, non-substantive modifications to the language of the draft plan are needed for clarity or consistency, directs the Executive Director or designee to make such changes and inform the State Water Board of any such changes.

5. Directs staff to initiate appropriate proceedings to amend the section 303(d) listing policy by February 2009.

CERTIFICATION

The undersigned Acting Clerk to the Board does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the State Water Resources Control Board held on September 16, 2008.

AYE: Chair Tam M. Doduc
Arthur G. Baggett, Jr.
Charles R. Hoppin
Frances Spivy-Weber
NAY: None

ABSENT: Vice Chair Gary Wolff, P.E., Ph.D

ABSTAIN: None

Jeanine Townsend

Jeanine Townsend
Clerk to the Board

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ATTACHMENTS

I. INTENT AND SUMMARY

A. INTENT OF PART 1 OF THE WATER QUALITY CONTROL PLAN FOR ENCLOSED BAYS AND ESTUARIES (PART 1)

It is the goal of the State Water Resources Control Board (State Water Board) to comply with the legislative directive in Water Code §13393 to adopt sediment quality objectives (SQOs). Part 1 integrates chemical and biological measures to determine if the sediment dependent biota are protected or degraded as a result of exposure to toxic pollutants* in sediment and to protect human health. Part 1 is not intended to address low dissolved oxygen, pathogens or nutrients including ammonia. Part 1 represents the first phase of the State Water Board's SQO development effort and focuses primarily on the protection of benthic* communities in enclosed bays* and estuaries*. The State Water Board has committed in the second phase to the refinement of benthic community protection indicators for estuarine waters and the development of an improved approach to address sediment quality related human health risk associated with consumption of fish tissue.

B. SUMMARY OF PART 1

Part 1 includes**:**

1. Narrative SQOs for the protection of aquatic life and human health;
2. Identification of the beneficial uses that these objectives are intended to protect;
3. A program of implementation that contains:
    a. Specific indicators, tools and implementation provisions to determine if the sediment quality at a station or multiple stations meets the narrative objectives;
    b. A description of appropriate monitoring programs; and
    c. A sequential series of actions that shall be initiated when a sediment quality objective is not met including stressor identification and evaluation of appropriate targets.
4. A glossary that defines all terms denoted by an asterisk

II. USE AND APPLICABILITY OF SQOS

A. AMBIENT SEDIMENT QUALITY

The SQOs and supporting tools shall be utilized to assess ambient sediment quality.

B. RELATIONSHIP TO OTHER NARRATIVE OBJECTIVES

1. Except as provided in 2 below, Part 1 supersedes all applicable narrative water quality objectives and related implementation provisions in water quality control plans (basin plans) to the extent that the objectives and provisions are applied to protect bay or estuarine benthic communities from toxic pollutants in sediments.
2. The supersession provision in 1. above does not apply to existing sediment cleanup activities where a site assessment was completed and submitted to the Regional Water Board by February 19, 2008.

C. APPLICABLE WATERS

Part 1 applies to enclosed bays[1] and estuaries[2] only. Part 1 does not apply to ocean waters* including Monterey Bay and Santa Monica Bay, or inland surface waters*.

D. APPLICABLE SEDIMENTS

Part 1 applies to subtidal surficial sediments* that have been deposited or emplaced seaward of the intertidal zone. Part 1 does not apply to:

1. Sediments characterized by less than five percent of fines or substrates composed of gravels, cobbles, or consolidated rock.
2. Sediment as the physical pollutant that causes adverse biological response or community degradation related to burial, deposition, or sedimentation.

E. APPLICABLE DISCHARGES

Part 1 is applicable in its entirety to point source* discharges. Nonpoint sources* of toxic pollutants are subject to Sections II, III, IV, V, and VI of Part 1.

III. BENEFICIAL USES

Beneficial uses protected by Part 1 and corresponding target receptors are identified in Table 1.

Table 1. Beneficial Uses and Target Receptors

Beneficial Uses	Target Receptors
Estuarine Habitat	Benthic Community
Marine Habitat	Benthic Community
Commercial and Sport Fishing	Human Health
Aquaculture	Human Health
Shellfish Harvesting	Human Health

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[1] ENCLOSED BAYS are indentations along the coast which enclose an area of oceanic water within distinct headlands or harbor works. Enclosed bays include all bays where the narrowest distance between headlands or outermost harbor works is less than 75 percent of the greatest dimension of the enclosed portion of the bay. This definition includes, but is not limited to: Humboldt Bay, Bodega Harbor, Tomales Bay, Drakes Estero, San Francisco Bay, Morro Bay, Los Angeles Harbor, Upper and Lower Newport Bay, Mission Bay, and San Diego Bay.

[2] ESTUARIES AND COASTAL LAGOONS are waters at the mouths of streams that serve as mixing zones for fresh and ocean waters during a major portion of the year. Mouths of streams that are temporarily separated from the ocean by sandbars shall be considered as estuaries. Estuarine waters will generally be considered to extend from a bay or the open ocean to the upstream limit of tidal action but may be considered to extend seaward if significant mixing of fresh and salt water occurs in the open coastal waters. The waters described by this definition include, but are not limited to, the Sacramento-San Joaquin Delta as defined by Section 12220 of CWC, Suisun Bay, Carquinez Strait downstream to Carquinez Bridge, and appropriate areas of the Smith, Klamath, Mad, Eel, Noyo, and Russian Rivers.

IV. SEDIMENT QUALITY OBJECTIVES

A. AQUATIC LIFE – BENTHIC COMMUNITY PROTECTION

Pollutants in sediments shall not be present in quantities that, alone or in combination, are toxic to benthic communities in bays and estuaries of California. This narrative objective shall be implemented using the integration of multiple lines of evidence (MLOE) as described in Section V of Part 1.

B. HUMAN HEALTH

Pollutants shall not be present in sediments at levels that will bioaccumulate in aquatic life to levels that are harmful to human health. This narrative objective shall be implemented as described in Section VI of Part 1.

V. BENTHIC COMMUNITY PROTECTION

A. MLOE APPROACH TO INTERPRET THE NARRATIVE OBJECTIVE

The methods and procedures described below shall be used to interpret the Narrative Objective described in Section IV.A. These tools are intended to assess the condition of benthic communities relative to potential for exposure to toxic pollutants in sediments. Exposure to toxic pollutants at harmful levels will result in some combination of a degraded benthic community, presence of toxicity, and elevated concentrations of pollutants in sediment. The assessment of sediment quality shall consist of the measurement and integration of three lines of evidence (LOE). The LOE are:

- ***Sediment Toxicity***—Sediment toxicity is a measure of the response of invertebrates exposed to surficial sediments under controlled laboratory conditions. The sediment toxicity LOE is used to assess both pollutant related biological effects and exposure. Sediment toxicity tests are of short durations and may not duplicate exposure conditions in natural systems. This LOE provides a measure of exposure to all pollutants present, including non-traditional or unmeasured chemicals.
- ***Benthic Community Condition***—Benthic community condition is a measure of the species composition, abundance and diversity of the sediment-dwelling invertebrates inhabiting surficial sediments*. The benthic community LOE is used to assess impacts to the primary receptors targeted for protection under Section IV.A. Benthic community composition is a measure of the biological effects of both natural and anthropogenic stressors.
- ***Sediment Chemistry***—Sediment chemistry is the measurement of the concentration of chemicals of concern* in surficial sediments. The chemistry LOE is used to assess the potential risk to benthic organisms from toxic pollutants in surficial sediments. The sediment chemistry LOE is intended only to evaluate overall exposure risk from chemical pollutants. This LOE does not establish causality associated with specific chemicals.

B. LIMITATIONS

None of the individual LOE is sufficiently reliable when used alone to assess sediment quality impacts due to toxic pollutants. Within a given site, the LOEs applied to assess exposure as described in Section V.A. may underestimate or overestimate the risk to benthic communities and do not indicate causality of specific chemicals. The LOEs applied to assess biological effects can respond to stresses associated with natural or physical factors, such as sediment grain size, physical disturbance, or organic enrichment.

Each LOE produces specific information that, when integrated with the other LOEs, provides a more confident assessment of sediment quality relative to the narrative objective. When the exposure and effects tools are integrated, the approach can quantify protection through effects measures and also provide predictive capability through the exposure assessment.

C. WATER BODIES

1. The tools described in the Sections V.D. through V.I. are applicable to Euhaline* Bays and Coastal Lagoons* south of Point Conception and Polyhaline* San Francisco Bay that includes the Central and South Bay Areas defined in general by waters south and west of the San Rafael Bridge and north of the Dumbarton Bridge.
2. For all other bays and estuaries where LOE measurement tools are unavailable, station assessment will follow the procedure described in Section V.J.

D. FIELD PROCEDURES

1. All samples shall be collected using a grab sampler.
2. Benthic samples shall be screened through:
   a. A 0.5 millimeter (mm)-mesh screen in San Francisco Bay and the Sacramento-San Joaquin Delta;
   b. A 1.0 mm-mesh screen in all other locations.
3. Surface sediment from within the upper 5 cm shall be collected for chemistry and toxicity analyses.
4. The entire contents of the grab sample, with a minimum penetration depth of 5 cm, shall be collected for benthic community analysis.
5. Bulk sediment chemical analysis will include at a minimum the pollutants identified in Attachment A.

E. LABORATORY TESTING

All samples will be tested in accordance with U.S. Environmental Protection Agency (USEPA) or American Society for Testing and Materials (ASTM) methodologies where such methods exist. Where no EPA or ASTM methods exist, the State Water Board or Regional Water Quality Control Boards (Regional Water Boards) (collectively Water Boards) shall approve the use of other methods. Analytical tests shall be conducted by laboratories certified by the California Department of Health Services in accordance with Water Code Section 13176.

F. SEDIMENT TOXICITY

1. Short Term Survival Tests—A minimum of one short-term survival test shall be performed on sediment collected from each station. Acceptable test organisms and methods are summarized in Table 2.

Table 2. Acceptable Short Term Survival Sediment Toxicity Test Methods

Test Organism	Exposure Type	Duration	Endpoint*
Eohaustorius estuarius	Whole Sediment	10 days	Survival
Leptocheirus plumulosus	Whole Sediment	10 days	Survival
Rhepoxynius abronius	Whole Sediment	10 days	Survival

2. Sublethal Tests—A minimum of one sublethal test shall be performed on sediment collected from each station. Acceptable test organisms and methods are summarized in Table 3.

Table 3. Acceptable Sublethal Sediment Toxicity Test Methods

Test Organism	Exposure Type	Duration	Endpoint
Neanthes arenaceodentata	Whole Sediment	28 days	Growth
Mytilus galloprovincialis	Sediment-water Interface	48 hour	Embryo Development

3. Assessment of Sediment Toxicity—Each sediment toxicity test result shall be compared and categorized according to responses in Table 4. The response categories are:
   a. Nontoxic—Response not substantially different from that expected in sediments that are uncontaminated and have optimum characteristics for the test species (e.g., control sediments).
   b. Low toxicity—A response that is of relatively low magnitude; the response may not be greater than test variability.
   c. Moderate toxicity—High confidence that a statistically significant toxic effect is present.
   d. High toxicity—High confidence that a toxic effect is present and the magnitude of response includes the strongest effects observed for the test.

Table 4. Sediment Toxicity Categorization Values

Test Species/ Endpoint	Statistical Significance	Nontoxic (Percent)	Low Toxicity (Percent of Control)	Moderate Toxicity (Percent of Control)	High Toxicity (Percent of Control)
Eohaustorius Survival	Significant	90 to 100	82 to 89	59 to 81	< 59
Eohaustorius Survival	Not Significant	82 to 100	59 to 81		<59
Leptocheirus Survival	Significant	90 to 100	78 to 89	56 to 77	<56
Leptocheirus Survival	Not Significant	78 to 100	56 to 77		<56
Rhepoxynius Survival	Significant	90 to 100	83 to 89	70 to 82	< 70
Rhepoxynius Survival	Not Significant	83 to 100	70 to 82		< 70
Neanthes Growth	Significant	90 to 100*	68 to 90	46 to 67	<46
Neanthes Growth	Not Significant	68 to 100	46 to 67		<46
Mytilus Normal	Significant	80 to 100	77 to 79	42 to 76	< 42
Mytilus Normal	Not Significant	77 to 79	42 to 76		< 42

* Expressed as a percentage of the control.

4. Integration of Sediment Toxicity Categories—The average of all test response categories shall determine the final toxicity LOE category. If the average falls midway between categories it shall be rounded up to the next higher response category.

G. BENTHIC COMMUNITY CONDITION

1. General Requirements.
    a. All benthic invertebrates in the screened sample shall be identified to the lowest possible taxon and counted.
    b. Taxonomic nomenclature shall follow current conventions established by local monitoring programs and professional organizations (e.g., master species list).
2. Benthic Indices—The benthic condition shall be assessed using the following methods:
    a. Benthic Response Index (BRI), which was originally developed for the southern California mainland shelf and extended into California's bays and estuaries. The BRI is the abundance-weighted average pollution* tolerance score of organisms occurring in a sample.
    b. Index of Biotic Integrity (IBI), which was developed for freshwater streams and adapted for California's bays and estuaries. The IBI identifies community measures that have values outside a reference range.
    c. Relative Benthic Index (RBI), which was developed for embayments in California's Bay Protection and Toxic Cleanup Program. The RBI is the weighted sum of: (a) several community parameters (total number of species, number of crustacean species, number of crustacean individuals, and number of mollusc species), and abundances of (b) three positive, and (c) two negative indicator species.
    d. River Invertebrate Prediction and Classification System (RIVPACS), which was originally developed for British freshwater streams and adapted for California's bays and estuaries. The approach compares the assemblage at a site with an expected species composition determined by a multivariate predictive model that is based on species relationships to habitat gradients.
3. Assessment of Benthic Community Condition—Each benthic index result shall be categorized according to disturbance as described in Table 5. The disturbance categories are:
    a. Reference—A community composition equivalent to a least affected or unaffected site.
    b. Low disturbance— A community that shows some indication of stress, but could be within measurement error of unaffected condition.
    c. Moderate disturbance—Confident that the community shows evidence of physical, chemical, natural, or anthropogenic stress.
    d. High disturbance—The magnitude of stress is high.
4. Integration of Benthic Community Categories—The median of all benthic index response categories shall determine the benthic condition LOE category. If the median falls between categories it shall be rounded up to the next higher effect category.

Table 5. Benthic Index Categorization Values

Index	Reference	Low Disturbance	Moderate Disturbance	High Disturbance
Southern California Marine Bays				
BRI	< 39.96	39.96 to 49.14	49.15 to 73.26	> 73.26
IBI	0	1	2	3 or 4
RBI	> 0.27	0.17 to 0.27	0.09 to 0.16	< 0.09
RIVPACS	> 0.90 to < 1.10	0.75 to 0.90 or 1.10 to 1.25	0.33 to 0.74 or > 1.25	< 0.33
Polyhaline Central San Francisco Bay				
BRI	< 22.28	22.28 to 33.37	33.38 to 82.08	> 82.08
IBI	0 or 1	2	3	4
RBI	> 0.43	0.30 to 0.43	0.20 to 0.29	< 0.20
RIVPACS	> 0.68 to < 1.32	0.33 to 0.68 or 1.32 to 1.67	0.16 to 0.32 or > 1.67	< 0.16

H. SEDIMENT CHEMISTRY

1. All samples shall be tested for the analytes identified in Attachment A—This list represents the minimum analytes required to assess exposure. In water bodies where other toxic pollutants are believed to pose risk to benthic communities, those toxic pollutants shall be included in the analysis. Inclusion of additional analytes cannot be used in the exposure assessment described below. However, the data can be used to conduct more effective stressor identification studies as described in Section VII. F.
2. Sediment Chemistry Guidelines—The sediment chemistry exposure shall be assessed using the following two methods:
   a. Chemical Score Index (CSI), that uses a series of empirical thresholds to predict the benthic community disturbance category (score) associated with the concentration of various chemicals (Table 6). The CSI is the weighted sum of the individual scores (Equation 1).

   Equation 1. $\mathrm{CSI} = \Sigma(w_i \times cat_i)/\Sigma w$

   Where: cat_i = predicted benthic disturbance category for chemical I;
   w_i = weight factor for chemical I;
   Σw = sum of all weights.

   b. California Logistic Regression Model (CA LRM), that uses logistic regression models to predict the probability of sediment toxicity associated with the concentration of various chemicals (Table 7 and Equation 2). The CA LRM exposure value is the maximum probability of toxicity from the individual models (P_{max})

   Equation 2. $p = e^{B0+B1\,(x)} / (1 + e^{B0+B1\,(x)})$

   Where: p = probability of observing a toxic effect;
   B0 = intercept parameter;
   B1 = slope parameter; and
   x = concentration the chemical.

Table 6. Category Score Concentration Ranges and Weighting Factors for the CSI

Chemical	Units	Weight	Score (Disturbance Category)			
			1 Reference	2 Low	3 Moderate	4 High
Copper	mg/kg	100	≤52.8	> 52.8 to 96.5	> 96.5 to 406	> 406
Lead	mg/kg	88	≤ 26.4	> 26.4 to 60.8	> 60.8 to 154	> 154
Mercury	mg/kg	30	≤ 0.09	> 0.09 to 0.45	> 0.45 to 2.18	> 2.18
Zinc	mg/kg	98	≤ 112	> 112 to 200	> 200 to 629	> 629
PAHs, total high MW	µg/kg	16	≤ 312	> 312 to 1325	> 1325 to 9320	>9320
PAHs, total low MW	µg/kg	5	≤ 85.4	> 85.4 to 312	> 312 to 2471	> 2471
Chlordane, alpha-	µg/kg	55	≤ 0.50	> 0.50 to 1.23	> 1.23 to 11.1	>11.1
Chlordane, gamma-	µg/kg	58	≤ 0.54	> 0.54 to 1.45	> 1.45 to 14.5	> 14.5
DDDs, total	µg/kg	46	≤ 0.50	> 0.50 to 2.69	> 2.69 to 117	> 117
DDEs, total	µg/kg	31	≤ 0.50	> 0.50 to 4.15	> 4.15 to 154	> 154
DDTs, total	µg/kg	16	≤ 0.50	> 0.50 to 1.52	> 1.52 to 89.3	> 89.3
PCBs, total	µg/kg	55	≤11.9	> 11.9 to 24.7	> 24.7 to 288	> 288

Table 7. CA LRM Regression Parameters

Chemical	Units	B0	B1
Cadmium	mg/kg	0.29	3.18
Copper	mg/kg	-5.59	2.59
Lead	mg/kg	-4.72	2.84
Mercury	mg/kg	-0.06	2.68
Zinc	mg/kg	-5.13	2.42
PAHs, total high MW	µg/kg	-8.19	2.00
PAHs, total low MW	µg/kg	-6.81	1.88
Chlordane, alpha	µg/kg	-3.41	4.46
Dieldrin	µg/kg	-1.83	2.59
Trans nonachlor	µg/kg	-4.26	5.31
PCBs, total	µg/kg	-4.41	1.48
p,p' DDT	µg/kg	-3.55	3.26

3. Assessment of Sediment Chemistry Exposure—Each sediment chemistry guideline result shall be categorized according to exposure as described in Table 8. The exposure categories are:
    a. Minimal exposure—Sediment-associated contamination* may be present, but exposure is unlikely to result in effects.
    b. Low exposure—Small increase in pollutant exposure that may be associated with increased effects, but magnitude or frequency of occurrence of biological impacts is low.
    c. Moderate exposure—Clear evidence of sediment pollutant exposure that is likely to result in biological effects; an intermediate category.
    d. High exposure—Pollutant exposure highly likely to result in possibly severe biological effects; generally present in a small percentage of the samples.

Table 8. Sediment Chemistry Guideline Categorization Values

Guideline	Minimal Exposure	Low Exposure	Moderate Exposure	High Exposure
CSI	< 1.69	1.69 to 2.33	2.34 to 2.99	>2.99
CA LRM	< 0.33	0.33 to 0.49	0.50 to 0.66	> 0.66

4. Integration of Sediment Chemistry Categories—The average of all chemistry exposure categories shall determine the final sediment chemistry LOE category. If the average falls midway between categories it shall be rounded up to the next higher exposure category.

I. INTERPRETATION AND INTEGRATION OF MLOE

Assessment as to whether the aquatic life sediment quality objective has been attained at a station is accomplished by the interpretation and integration of MLOE. The categories assigned to the three LOE, sediment toxicity, benthic community condition and sediment chemistry are evaluated to determine the station level assessment. The assessment category represented by each of the possible MLOE combinations reflects the presence and severity of two characteristics of the sample: severity of biological effects, and potential for chemically-mediated effects.

1. Severity of Biological Effects—The severity of biological effects present at a site shall be determined by the integration of the toxicity LOE and benthic condition LOE categories using the decision matrix presented in Table 9.
2. Potential for Chemically-Mediated Effects—The potential for effects to be chemically-mediated shall be determined by the integration of the toxicity LOE and chemistry LOE categories using the decision matrix presented in Table 10.

Table 9. Severity of Biological Effects Matrix

		Toxicity LOE Category			
		Nontoxic	**Low Toxicity**	**Moderate Toxicity**	**High Toxicity**
Benthic Condition LOE Category	Reference	Unaffected	Unaffected	Unaffected	Low Effect
	Low Disturbance	Unaffected	Low Effect	Low Effect	Low Effect
	Moderate Disturbance	Moderate Effect	Moderate Effect	Moderate Effect	Moderate Effect
	High Disturbance	Moderate Effect	High Effect	High Effect	High Effect

Table 10. Potential for Chemically Mediated Effects Matrix

		Toxicity LOE Category			
		Nontoxic	**Low Toxicity**	**Moderate Toxicity**	**High Toxicity**
Sediment Chemistry LOE Category	Minimal Exposure	Minimal Potential	Minimal Potential	Low Potential	Moderate Potential
	Low Exposure	Minimal Potential	Low Potential	Moderate Potential	Moderate Potential
	Moderate Exposure	Low Potential	Moderate Potential	Moderate Potential	Moderate Potential
	High Exposure	Moderate Potential	Moderate Potential	High Potential	High Potential

3. Station Level Assessment—The station level assessment shall be determined using the decision matrix presented in Table 11. This assessment combines the intermediate classifications for severity of biological effect and potential for chemically-mediated effect to result in six categories of impact at the station level:

   a. Unimpacted—Confident that sediment contamination is not causing significant adverse impacts to aquatic life living in the sediment at the site.

   b. Likely Unimpacted—Sediment contamination at the site is not expected to cause adverse impacts to aquatic life, but some disagreement among the LOE reduces certainty in classifying the site as unimpacted.

   c. Possibly Impacted—Sediment contamination at the site may be causing adverse impacts to aquatic life, but these impacts are either small or uncertain because of disagreement among LOE.

   d. Likely Impacted—Evidence for a contaminant-related impact to aquatic life at the site is persuasive, even if there is some disagreement among LOE.

   e. Clearly Impacted—Sediment contamination at the site is causing clear and severe adverse impacts to aquatic life.

   f. Inconclusive—Disagreement among the LOE suggests that either the data are suspect or that additional information is needed before a classification can be made.

Table 11. Station Assessment Matrix

		Severity of Effect			
		Unaffected	**Low Effect**	**Moderate Effect**	**High Effect**
Potential For Chemically-Mediated Effects	Minimal Potential	Unimpacted	Likely Unimpacted	Likely Unimpacted	Inconclusive
	Low Potential	Unimpacted	Likely Unimpacted	Possibly Impacted	Possibly Impacted
	Moderate Potential	Likely Unimpacted	Possibly Impacted or Inconclusive[1]	Likely Impacted	Likely Impacted
	High Potential	Inconclusive	Likely Impacted	Clearly Impacted	Clearly Impacted

[1] Inconclusive category when chemistry is classified as minimal exposure, benthic response is classified as reference, and toxicity response is classified as high.

The station assessment resulting from each possible combination of the three LOEs is shown in Attachment B. As an alternative to Tables 9, 10 and 11, each LOE category can be applied to Attachment B to determine the overall condition of the station. The results will be the same regardless of the tables used.

4. Relationship to the Aquatic Life – Benthic Community Protection Narrative Objective.
    a. The categories designated as **Unimpacted** and **Likely Unimpacted** shall be considered as achieving the protective condition at the station. All other categories shall be considered as degraded except as provided in b. below.
    b. The Water Board shall designate the category **Possibly Impacted** as meeting the protective condition if the studies identified in Section VII.F demonstrate that the combination of effects and exposure measures are not responding to toxic pollutants in sediments and that other factors are causing these responses within a specific reach segment or waterbody. In this situation, the Water Board will consider only the Categories **Likely Impacted** and **Clearly Impacted** as degraded when making a determination on receiving water limits and impaired water bodies described in Section VII.

J. MLOE APPROACH TO INTERPRET THE NARRATIVE OBJECTIVE IN OTHER BAYS AND ESTUARIES

Station assessments for waterbodies identified in Section V.C.2. will be conducted using the same conceptual approach and similar tools to those described in Sections V.D-H. Each LOE will be evaluated by measuring a set of readily available indicators in accordance with Tables 12 and 13.

1. Station assessment shall be consistent with the following key principles of the assessment approach described in Sections V.D. through V.I:
    a. Results for a single LOE shall not be used as the basis for an assessment.
    b. Evidence of both elevated chemical exposure and biological effects must be present to indicate pollutant-associated impacts.
    c. The categorization of each LOE shall be based on numeric values or a statistical comparison.
2. Lines of Evidence and Measurement Tools—Sediment chemistry, toxicity, and benthic community condition shall be measured at each station. Table 12 lists the required tools for evaluation of each LOE. Each measurement shall be conducted using standardized methods (e.g., EPA or ASTM guidance) where available.
3. Categorization of LOEs—Determination of the presence of an LOE effect (i.e., biologically significant chemical exposure, toxicity, or benthic community disturbance) shall be based on a comparison to a numeric response value or a statistical comparison to reference stations. The numeric values or statistical comparisons (e.g., confidence interval) used to classify a LOE as Effected shall be comparable to those specified in Sections V.F-H. to indicate High Chemical Exposure, High Toxicity, or High Disturbance. Reference stations shall be located in an area expected to be uninfluenced by the discharge or pollutants of concern in the assessment area and shall be representative of other habitat characteristics of the assessment area (e.g., salinity, grain size). Comparison to reference shall be accomplished by compiling data for appropriate regional reference sites and determining the reference envelope using statistical methods (e.g., tolerance interval).

Table 12. Tools for Use in Evaluation of LOEs

LOE	Tools	Metrics
Chemistry	Bulk sediment chemistry to include existing list (Attachment A) plus other chemicals of concern	CA LRM P_{max} Concentration on a dry weight basis
Sediment Toxicity	10-Day amphipod survival using a species tolerant of the sample salinity and grain size characteristics. e.g., *Hyalella azteca* or *Eohaustorius estuarius*	Percent of control survival
Benthic Community Condition	Invertebrate species identification and abundance	Species richness* Presence of sensitive indicator taxa Dominance by tolerant indicator taxa Presence of diverse functional and feeding groups Total abundance

Table 13. Numeric Values and Comparison Methods for LOE Categorization

Metric	Threshold value or Comparison
CA LRM	Pmax > 0.66
Chemical Concentration	Greater than reference range or interval
Percent of Control Survival	*E. estuarius*: < 59 *H. azteca*: < 62 or SWAMP criterion
Species Richness	Less than reference range or interval
Abundance of Sensitive Indicator Taxa	Less than reference range or interval
Abundance of Tolerant Indicator Taxa	Greater than reference range or interval
Total Abundance	Outside of reference range or interval

4. Station Level Assessment—The station level assessment shall be determined using the decision matrix presented in Table 14. This assessment combines the classifications for each LOE to result in two categories of impact at the station level:
   a. Unimpacted—No conclusive evidence of both high pollutant exposure and high biological effects present at the site. Evidence of chemical exposure and biological effects may be within natural variability or measurement error.
   b. Impacted—Confident that sediment contamination present at the site is causing adverse direct impacts to aquatic life.

Table 14. Station Assessment Matrix for Other Bays and Estuaries

Chemistry LOE Category	Toxicity LOE Category	Benthic Condition LOE Category	Station Assessment
No effect	No effect	No effect	Unimpacted
No effect	No effect	Effect	Unimpacted
No effect	Effect	No effect	Unimpacted
No effect	Effect	Effect	Impacted
Effect	No effect	No effect	Unimpacted
Effect	No effect	Effect	Impacted
Effect	Effect	No effect	Impacted
Effect	Effect	Effect	Impacted

5. Relationship to the Aquatic Life – Benthic Community Protection Narrative Objective—The category designated as **Unimpacted** shall be considered as achieving the protective condition at the station.

VI. HUMAN HEALTH

The narrative human health objective in Section IV. B. of this Part 1 shall be implemented on a case-by-case basis, based upon a human health risk assessment. In conducting a risk assessment, the Water Boards shall consider any applicable and relevant information, including California Environmental Protection Agency's (Cal/EPA) Office of Environmental Health Hazard Assessment (OEHHA) policies for fish consumption and risk assessment, Cal/EPA's Department of Toxic Substances Control (DTSC) Risk Assessment, and USEPA Human Health Risk Assessment policies.

VII. PROGRAM OF IMPLEMENTATION

Implementation of Part 1 shall be conducted in accordance with the following provisions and consistent with the process shown in Figures 1 and 2.

A. DREDGE MATERIALS

1. Part 1 shall not apply to dredge material suitability determinations.
2. The Water Boards shall not approve a dredging project that involves the dredging of sediment that exceeds the objectives in Part 1, unless the Water Boards determine that:
   a. The polluted sediment is removed in a manner that prevents or minimizes water quality degradation.
   b. The polluted sediment is not deposited in a location that may cause significant adverse effects to aquatic life, fish, shellfish, or wildlife or may harm the beneficial uses of the receiving waters, or does not create maximum benefit to the people of the State.
   c. The activity will not cause significant adverse impacts upon a federal sanctuary, recreational area, or other waters of significant national importance.

B. NPDES RECEIVING WATER AND EFFLUENT LIMITS

1. If a Water Board determines that discharge of a toxic pollutant to bay or estuarine waters has the reasonable potential to cause or contribute to an exceedance of the SQOs, the Water Board shall apply the objectives as receiving water limits.
2. The Permittee shall be in violation of such limits if it is demonstrated that the discharge is causing or contributing to the SQO exceedance as defined in Section VII.C.
3. Receiving water monitoring required by an NPDES permit may be satisfied by a Permitee's participation in a regional SQO monitoring program described in Section VII.E.
4. The sediment chemistry guidelines shall not be translated into or applied as effluent limits. Effluent limits established to protect or restore sediment quality shall be developed only after:
   a. A clear relationship has been established linking the discharge to the degradation,

b. The pollutants causing or contributing to the degradation have been identified, and

c. Appropriate loading studies have been completed to estimate the reductions in pollutant loading that will restore sediment quality.

These actions are described further in Sections VII.F and VII.G. Nothing in this section shall limit a Water Board's authority to develop and implement waste* load allocations* for Total Maximum Daily Loads. However, it is recommended that the Water Boards develop TMDL allocations using the methodology described herein, wherever possible.

C. EXCEEDANCE OF RECEIVING WATER LIMIT

Exceedance of a receiving water limit is demonstrated when:

1. Using a binomial distribution*, the total number of stations designated as not meeting the protective condition as defined in Sections V.I.4. or V.J.4. supports rejection of the null hypothesis* as presented in Table 15. The stations included in this analysis will be those located in the vicinity of the discharge and identified in the permit, and
2. It is demonstrated that the discharge is causing or contributing to the SQO exceedance, following the completion of the stressor identification studies described in Section VII.F.
3. If studies by the Permittee demonstrate that other sources may also be contributing to the degradation of sediment quality, the Regional Water Board shall, as appropriate, require the other sources to initiate studies to assess the extent to which these sources are a contributing factor.

Table 15. Minimum Number of Measured Exceedances Needed to Exceed the Direct Effects SQO as a Receiving Water Limit

Sample Size	List If the Number of Exceedances Equals or Is Greater Than
2 – 24	2*
25 – 36	3
37 – 47	4
48 – 59	5
60 – 71	6
72 – 82	7
83 – 94	8
95 – 106	9
107 – 117	10
118 – 129	11

Note: Null Hypothesis: Actual exceedance proportion ≤ 3 percent. Alternate Hypothesis: Actual exceedance proportion > 18 percent. The minimum effect size* is 15 percent.

*Application of the binomial test requires a minimum sample size of 16. The number of exceedances required using the binomial test at a sample size of 16 is extended to smaller sample sizes.

Exceedance will require the Permittee to perform additional studies as described in Sections VII.F and VII.G.

D. RECEIVING WATER LIMITS MONITORING FREQUENCY

1. Phase I Stormwater Discharges and Major Discharges—Sediment Monitoring shall not be required less frequently than twice per permit cycle. For Stations that are consistently classified as unimpacted or likely unimpacted the frequency may be reduced to once per permit cycle. The Water Board may limit receiving water monitoring to a subset of outfalls for Phase I Stormwater Permitees.
2. Phase II Stormwater and Minor Discharges—Sediment Monitoring shall not be required more often then twice per permit cycle or less then once per permit cycle. For stations that are consistently classified as unimpacted or likely unimpacted, the number of stations monitored may be reduced at the discretion of the Water Board. The Water Board may limit receiving water monitoring to a subset of outfalls for Phase II Stormwater Permitees.
3. Other Regulated Discharges and Waivers—The frequency of the monitoring for receiving water limits for other regulated discharges and waivers will be determined by the Water Board.

E. SEDIMENT MONITORING

1. Objective—Bedded sediments in bays contain an accumulation of pollutants from a wide variety of past and present sources discharged either directly into the bay or indirectly into waters draining into the bay. Embayments also represent highly disturbed or altered habitats as a result of dredging and physical disturbance caused by construction and maintenance of harbor works, boat and ship traffic, and development of adjacent lands. Due to the multitude of stressors and the complexity of the environment, a well-designed monitoring program is necessary to ensure that the data collected adequately characterizes the condition of sediment in these water bodies.
2. Permitted Discharges—Monitoring may be performed by individual Permitees to assess compliance with receiving water limits, or through participation in a regional or water body monitoring coalition as described under VII.E.3, or both as determined by the Water Board.
3. Monitoring Coalitions—To achieve maximum efficiency and economy of resources, the State Water Board encourages the regulated community in coordination with the Regional Water Boards to establish water body-monitoring coalitions. Monitoring coalitions enable the sharing of technical resources, trained personnel, and associated costs and create an integrated sediment-monitoring program within each major water body. Focusing resources on regional issues and developing a broader understanding of pollutants effects in these water bodies enables the development of more rapid and efficient response strategies and facilitates better management of sediment quality.
    a. If a regional monitoring coalition is established, the coalition shall be responsible for sediment quality assessment within the designated water body and for ensuring that appropriate studies are completed in a timely manner.
    b. The Water Board shall provide oversight to ensure that coalition participants are proactive and responsive to potential sediment quality related issues as they arise during monitoring and assessment.
    c. Each regional monitoring coalition shall prepare a workplan that describes the monitoring, a map of the stations, participants and a schedule that shall be submitted to the Water Board for approval.

4. Methods—Sediments collected from each station shall be tested or assessed using the methods and metrics described in Section V.
5. Design.
   a. The design of sediment monitoring programs, whether site-specific or region wide, shall be based upon a conceptual model. A conceptual model is useful for identifying the physical and chemical factors that control the fate and transport of pollutants and receptors that could be exposed to pollutants in the sediment. The conceptual model serves as the basis for assessing the appropriateness of a study design. The detail and complexity of the conceptual model is dependent upon the scope and scale of the monitoring program. A conceptual model shall consider:
      - Points of discharge into the segment of the waterbody or region of interest
      - Tidal flow and/or direction of predominant currents
      - Historic and or legacy conditions in the vicinity
      - Nearby land and marine uses or actions
      - Beneficial uses
      - Potential receptors of concern
      - Changes in grain size salinity water depth and organic matter
      - Other sources or discharges in the immediate vicinity.
   b. Sediment monitoring programs shall be designed to ensure that the aggregate stations are spatially representative of the sediment within the water body.
   c. The design shall take into consideration existing data and information of appropriate quality.
   d. Stratified random design shall be used where resources permit to assess conditions throughout a water body.
   3. Identification of appropriate strata shall consider characteristics of the water body including sediment transport, hydrodynamics, depth, salinity, land uses, inputs (both natural and anthropogenic) and other factors that could affect the physical, chemical, or biological condition of the sediment.
   f. Targeted designs shall be applied to those Permitees that are required to meet receiving water limits as described in Section VII. B.
6. Index Period—All stations shall be sampled between the months of June through September to be consistent with the benthic community condition index period.
7. Regional Monitoring Schedule and Frequency.
   a. Regional sediment quality monitoring will occur at a minimum of once every three years.
   b. Sediments identified as exceeding the narrative objective will be evaluated more frequently.
8. Evaluating Waters for placement on the Section 303(d) list —In California, water segments are placed on the section 303(d) list for sediment toxicity based either on toxicity alone or toxicity that is associated with a pollutant. The listing criteria are contained in the State Water Board's Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (2004)(Listing Policy). Part 1 adds an additional listing criterion that applies only to listings for exceedances of the narrative sediment quality objective for aquatic life protection in Section IV.A. The criterion under Part 1 is described in subsection a. below and the relationship

between the sediment toxicity listing criteria under the Listing Policy and the criterion under Part 1 is described in subsections b. and c., below.

1. Water segments shall be placed on the section 303(d) list for exceedance of the narrative sediment quality objective for aquatic life protection in Section IV.A. of Part 1 only if the number of stations designated as not achieving the protective condition as defined in Sections V.I. and V.J. supports rejection of the null hypothesis, as provided in Table 3.1 of the State Water Board's Listing Policy.
2. Water segments that exhibit sediment toxicity but that are not listed for an exceedance of the narrative sediment quality objective for aquatic life protection in Section IV.A. shall continue to be listed in accordance with Section 3.6 of the Listing Policy.
3. If a water segment is listed under Section 3.6 of the Listing Policy and the Regional Water Board later determines that the applicable water quality standard that is impaired consists of the sediment quality objective in Section IV.A. of Part 1 and a bay or estuarine habitat beneficial use, the Regional Water Board shall reevaluate the listing in accordance with Sections V.I and V.J. If the Regional Water Board reevaluates the listing and determines that the water segment does not meet the criteria in subsection a. above, the Regional Water Board shall delist the water segment.

F. STRESSOR IDENTIFICATION

If sediments fail to meet the narrative SQOs in accordance with Sections V. and VI. the Water Boards shall direct the regional monitoring coalitions or Permittees to conduct stressor identification.

The Water Boards shall assign the highest priority for stressor identification to those segments or reaches with the highest percentage of sites designated as Clearly Impacted and Likely Impacted.

Where segments or reaches contain Possibly Impacted but no Clearly or Likely Impacted sites, confirmation monitoring shall be conducted prior to initiating stressor identification.

The stressor identification approach consists of development and implementation of a work plan to seek confirmation and characterization of pollutant-related impacts, pollutant identification and source identification. The workplan shall be submitted to the Water Board for approval. Stressor identification consists of the following studies:

1. Confirmation and Characterization of Pollutant Related Impacts—Exceedance of the direct effects SQO at a site indicates that pollutants in the sediment are the likely cause but does not identify the specific pollutant responsible. The MLOE assessment establishes a linkage to sediment pollutants; however, the lack of confounding factors (e.g., physical disturbance, non-pollutant constituents) must be confirmed. There are two generic stressors that are not related to toxic pollutants that may cause the narrative to be exceeded:
    a. Physical Alteration—Examples of physical stressors include reduced salinity, impacts from dredging, very fine or coarse grain size, and prop wash from passing ships. These types of stressors may produce a non-reference condition* in the benthic community that is similar to that caused by pollutants. If impacts to a site are purely due to physical disturbance, the LOE characteristics will likely show a degraded benthic community with little or no toxicity and low chemical concentrations.

    b. Other Pollutant Related Stressors—These constituents, which include elevated total organic carbon, ammonia, nutrients and pathogens, may have sources similar to chemical pollutants. Chemical and microbiological analysis will be necessary to determine if these constituents are present. The LOE characteristics for this type of stressor would likely be a degraded benthic community with possibly an indication of toxicity, and low chemical concentrations.

    To further assess a site that is impacted by toxic pollutants, there are several lines of investigation that may be pursued, depending on site-specific conditions. These studies may be considered and evaluated in the work plan for the confirmation effort:

    a. Evaluate the spatial extent of the Area of Concern. This information can be used to evaluate the potential risk associated with the sediment, distinguish areas of known physical disturbance or pollution and evaluate the proximity to anthropogenic source gradient from such inputs as outfalls, storm drains, and industrial and agricultural activities.
    b. Body burden data may be examined from animals exposed to the site's sediment to indicate if pollutants are being accumulated and to what degree.
    c. Chemical specific mechanistic benchmarks* may be applied to interpret sediment chemistry concentrations.
    d. Chemistry and biology data from the site should be examined to determine if there is a correlation between the two LOE.
    e. Alternate biological effects data may be pursued, such as bioaccumulation* experiments and pore water toxicity or chemical analysis.
    f. Other investigations that may commonly be performed as part of a Phase 1 Toxicity Identification Evaluation* (TIE).

    If there is compelling evidence that the SQO exceedances contributing to a receiving water limit exceedance are not due to toxic pollutants, then the assessment area shall be designated as having achieved the receiving water limit.

2. Pollutant Identification—Methods to help determine cause may be statistical, biological, chemical or a combination. Pollutant identification studies should be structured to address site-specific conditions, and may be based upon the following:

    a. Statistical methods—Correlations between individual chemicals and biological endpoints (toxicity and benthic community).
    b. Gradient analysis—Comparisons are made between different samples taken at various distances from a chemical hotspot to examine patterns in chemical concentrations and biological responses. The concentrations of causative agents should decrease as biological effects decrease.
    c. Additional Toxicity Identification Evaluation efforts—A toxicological method for determining the cause of impairments is the use of toxicity identification evaluations (TIE). Sediment samples are manipulated chemically or physically to remove classes of chemicals or render them biologically unavailable. Following the manipulations, biological tests are performed to determine if toxicity has been removed. TIEs should be conducted at a limited number of stations, preferably those with strong biological or toxicological effects.
    d. Bioavailability*—Chemical pollutants may be present in the sediment but not biologically available to cause toxicity or degradation of the benthic community. There are several measures of bioavailability that can be made. Chemical and

toxicological measurements can be made on pore water to determine the availability of sediment pollutants. Metal compounds may be naturally bound up in the sediment and rendered unavailable by the presence of sulfides. Measurement of acid volatile sulfides and simultaneously extracted metals analysis can be conducted to determine if sufficient sulfides are present to bind the observed metals. Similarly, organic compounds can be tightly bound to sediments. Measurements of sediment organic carbon and other binding phases can be conducted to determine the bioavailable fraction of organic compounds. Solid phase microextraction (SPME) or laboratory desorption experiments can also be used to identify which organics are bioavailable to benthic organisms.

   e. Verification—After specific chemicals are identified as likely causes of impairment, analysis should be performed to verify the results. Sediments can be spiked with the suspected chemicals to verify that they are indeed toxic at the concentrations observed in the field. Alternately, animals can be transplanted to suspected sites for *in situ* toxicity and bioaccumulation testing.

When stressor Identification yields inconclusive results for sites classified as Possibly Impacted, the Water Board shall require the Permittee or regional monitoring coalition to perform a one-time augmentation to that study or, alternatively, the Water Board may suspend further stressor identification studies pending the results of future routine SQO monitoring.

3. Sources Identification and Management Actions.
   a. Determine if the sources are ongoing or legacy sources.
   b. Determine the number and nature of ongoing sources.
   c. If a single discharger is found to be responsible for discharging the stressor pollutant at a loading rate that is significant, the Regional Water Board shall require the discharger to take all necessary and appropriate steps to address exceedance of the SQO, including but not limited to reducing the pollutant loading into the sediment.
   d. When multiple sources are present in the water body that discharge the stressor pollutant at a loading rate that is significant, the Regional Water Board shall require the sources to take all necessary and appropriate steps to address exceedance of the SQO. If appropriate, the Regional Water Board may adopt a TMDL to ensure attainment of the sediment standard.

G. CLEANUP AND ABATEMENT

Cleanup and abatement actions covered by Water Code section 13304 for sediments that exceed the objectives in Chapter IV shall comply with Resolution No. 92-49 (Policies and Procedures for Investigation and Cleanup and Abatement of Discharges under Water Code Section 13304), Cal. Code Regs., tit. 23, §§2907, 2911.

H. DEVELOPMENT OF SITE-SPECIFIC SEDIMENT MANAGEMENT GUIDELINES

The Regional Water Boards may develop site-specific sediment management guidelines where appropriate, for example, where toxic stressors have been identified and controllable sources of these stressors exist or remedial goals are desired.

Development of site-specific sediment management guidelines is the process to estimate the level of the stressor pollutant that will meet the narrative sediment quality objective. The guideline can serve as the basis for cleanup goals or revision of effluent limits described in B. 4

above, depending upon the situation or sources. All guidelines when applied for cleanup, must comply with 92-49.

Guideline development should only be initiated after the stressor has been identified. The goal is to establish a relationship between the organism's exposure and the biological effect. Once this relationship is established, a pollutant specific guideline may be designated that corresponds with minimum biological effects. The following approaches can be applied to establish these relationships:

1. Correspondence with sediment chemistry. An effective guideline can best be derived based upon the site-specific, or reach- specific relationship between the stressor pollutant exposure and biological response. Therefore the correspondence between the bulk sediment stressor concentration and biological effects should be examined.
2. Correspondence with bioavailable pollutant concentration. The concentration of the bioavailable fraction of the stressor pollutants is likely to show a less variable relationship to biological effects that bulk sediment chemistry. Interstitial water analysis, SPME, desorption experiments, selective extractions, or mechanistic models may indicate the bioavailable pollutant concentration. The correspondence between the bioavailable stressor concentration and biological effects should be examined.
3. Correspondence with tissue residue. The concentration of the stressor accumulated by a target organism may provide a measure of the stressor dose for some chemicals (e.g., those that are not rapidly metabolized). The tissue residue threshold concentration associated with unacceptable biological effects can be combined with a bioaccumulation factor or model to estimate the loading or sediment concentration guideline.
4. Literature review. If site-specific analyses are ambiguous or unable to determine a guideline, then the results of similar development efforts for other areas should be reviewed. Scientifically credible values from other studies can be combined with mechanistic or empirical models of bioavailability, toxic potency, and organism sensitivity to estimate guidelines for the area of interest.
5. The chemistry LOE of Section V.H.2, including the threshold values (e.g. CSI and CALRM), shall not be used for setting cleanup levels or numeric values for technical TMDLs.

VIII. GLOSSARY

BENTHIC: Living on or in bottom of the ocean, bays, and estuaries, or in the streambed.

BINOMIAL DISTRIBUTION: Mathematical distribution that describes the probabilities associated with the possible number of times particular outcomes will occur in series of observations (i.e., samples). Each observation may have only one of two possible results (e.g., standard exceeded or standard not exceeded).

BIOACCUMULATION: A process in which an organism's body burden of a pollutant exceeds that in its surrounding environment as a result of chemical uptake through all routes of chemical exposure; dietary and dermal absorption and transport across the respiratory surface.

BIOAVAILABILITY: The fraction of a pollutant that an organism is exposed to that is available for uptake through biological membranes (gut, gills).

CHEMICALS OF CONCERN (COCS): Pollutants that occur in environmental media at levels that pose a risk to ecological receptors or human health.

CONTAMINATION: An impairment of the quality of the waters of the State by waste to a degree that creates a hazard to the public health through poisoning or through the spread of disease. “Contamination” includes any equivalent effect resulting from the disposal of waste whether or not waters of the State are affected (CWC section 13050(k)).

EFFECT SIZE: The maximum magnitude of exceedance frequency that is tolerated.

ENCLOSED BAYS: Indentations along the coast that enclose an area of oceanic water within distinct headlands or harbor works. Enclosed bays include all bays where the narrowest distance between headlands or outermost harbor works is less than 75 percent of the greatest dimension of the enclosed portion of the bay. This definition includes, but is not limited to: Humboldt Bay, Bodega Harbor, Tomales Bay, Drakes Estero, San Francisco Bay, Morro Bay, Los Angeles Harbor, Upper and Lower Newport Bay, Mission Bay, and San Diego Bay.

ENDPOINT: A measured response of a receptor to a stressor. An endpoint can be measured in a toxicity test or in a field survey.

ESTUARIES AND COASTAL LAGOONS: Waters at the mouths of streams that serve as mixing zones* for fresh and ocean waters during a major portion of the year. Mouths of streams that are temporarily separated from the ocean by sandbars shall be considered as estuaries. Estuarine waters will generally be considered to extend from a bay or the open ocean to the upstream limit of tidal action but may be considered to extend seaward if significant mixing of fresh and salt water occurs in the open coastal waters. The waters described by this definition include, but are not limited to, the Sacramento-San Joaquin Delta as defined by Section 12220 of the California Water Code, Suisun Bay, Carquinez Strait downstream to Carquinez Bridge, and appropriate areas of the Smith, Klamath, Mad, Eel, Noyo, and Russian Rivers.

EUHALINE: Waters ranging in salinity from 25–32 practical salinity units (psu).

INLAND SURFACE WATERS: All surface waters of the State that do not include the ocean, enclosed bays, or estuaries.

LOAD ALLOCATION (LA): The portion of a receiving water's total maximum daily load that is allocated to one of its nonpoint sources of pollution or to natural background sources.

MECHANISTIC BENCHMARKS: Chemical guidelines developed based upon theoretical processes governing bioavailability and the relationship to biological effects.

MIXING ZONE: A limited zone within a receiving water that is allocated for mixing with a wastewater discharge where water quality criteria can be exceeded without causing adverse effects to the overall water body.

NONPOINT SOURCES: Sources that do not meet the definition of a point source as defined below.

NULL HYPOTHESIS: A statement used in statistical testing that has been put forward either because it is believed to be true or because it is to be used as a basis for argument, but has not been proved.

OCEAN WATERS: Territorial marine waters of the State as defined by California law to the extent these waters are outside of enclosed bays, estuaries, and coastal lagoons. Discharges to ocean waters are regulated in accordance with the State Water Board’s California Ocean Plan.

POINT SOURCE: Any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural stormwater discharges and return flows from irrigated agriculture.

POLLUTANT: Defined in section 502(6) of the CWA as “dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water.”

POLLUTION: Defined in section 502(19) of the CWA as the “the man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water.” *Pollution* is also defined in CWC section 13050(1) as an alternation of the quality of the waters of the State by waste to a degree that unreasonably affects either the waters for beneficial uses or the facilities that serve these beneficial uses.

POLYHALINE: Waters ranging in salinity from 18–25 psu.

REFERENCE CONDITION: The characteristics of water body segments least impaired by human activities. As such, reference conditions can be used to describe attainable biological or habitat conditions for water body segments with common watershed/catchment characteristics within defined geographical regions.

SPECIES RICHNESS: The number of species in a sample.

SURFICIAL SEDIMENTS: Those sediments representing recent depositional materials and containing the majority of the benthic invertebrate community.

STATISTICAL SIGNIFICANCE: When it can be demonstrated that the probability of obtaining a difference by chance only is relatively low.

TOXICITY IDENTIFICATION EVALUATION (TIE): Techniques used to identify the unexplained cause(s) of toxic events. TIE involves selectively removing classes of chemicals through a series of sample manipulations, effectively reducing complex mixtures of chemicals in natural waters to simple components for analysis. Following each manipulation the toxicity of the sample is assessed to see whether the toxicant class removed was responsible for the toxicity.

WASTE: As used in this document, waste includes a discharger’s total discharge, of whatever origin, i.e., gross, not net, discharge.

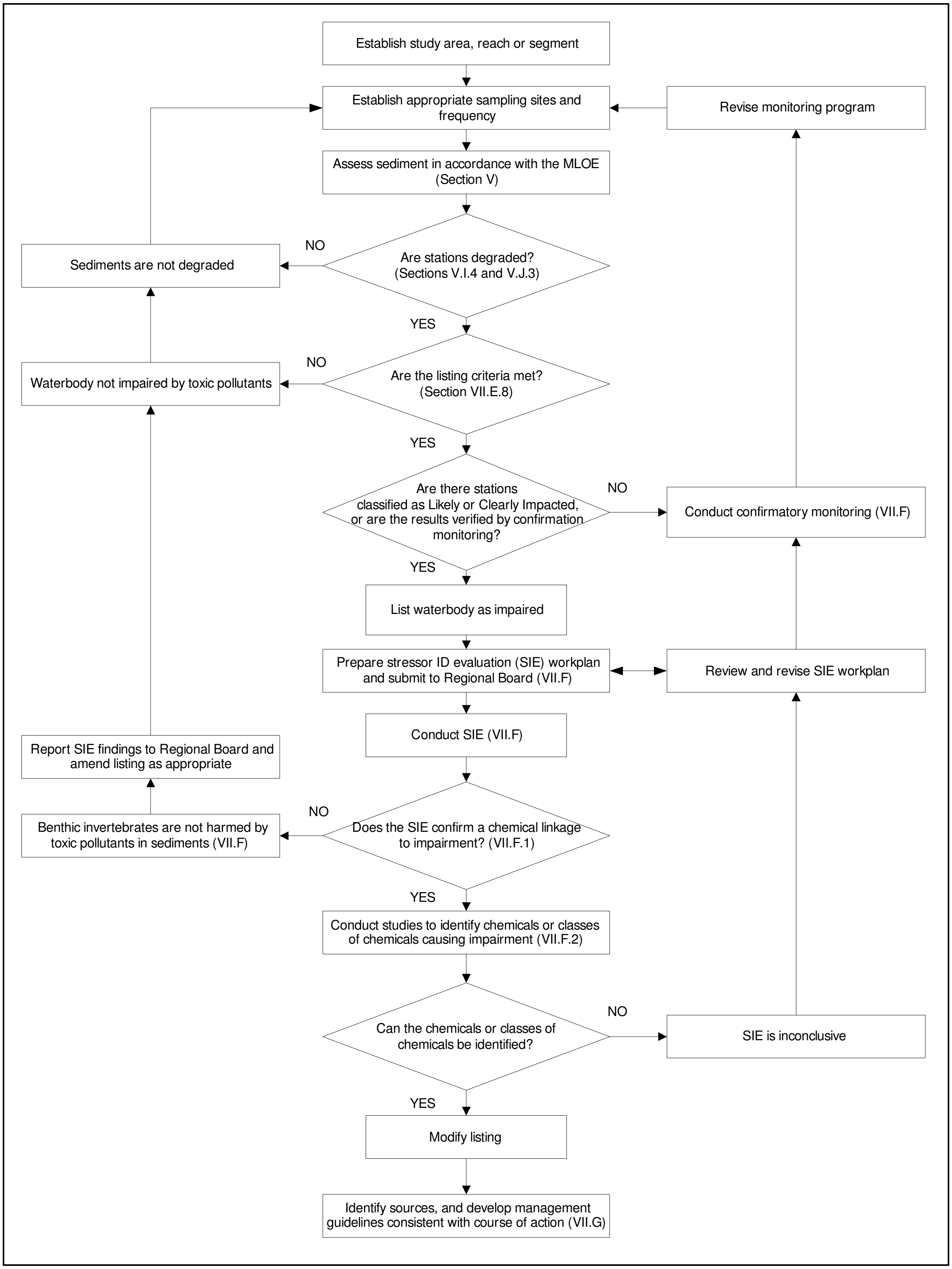

Figure 1. Waterbody Assessment Process

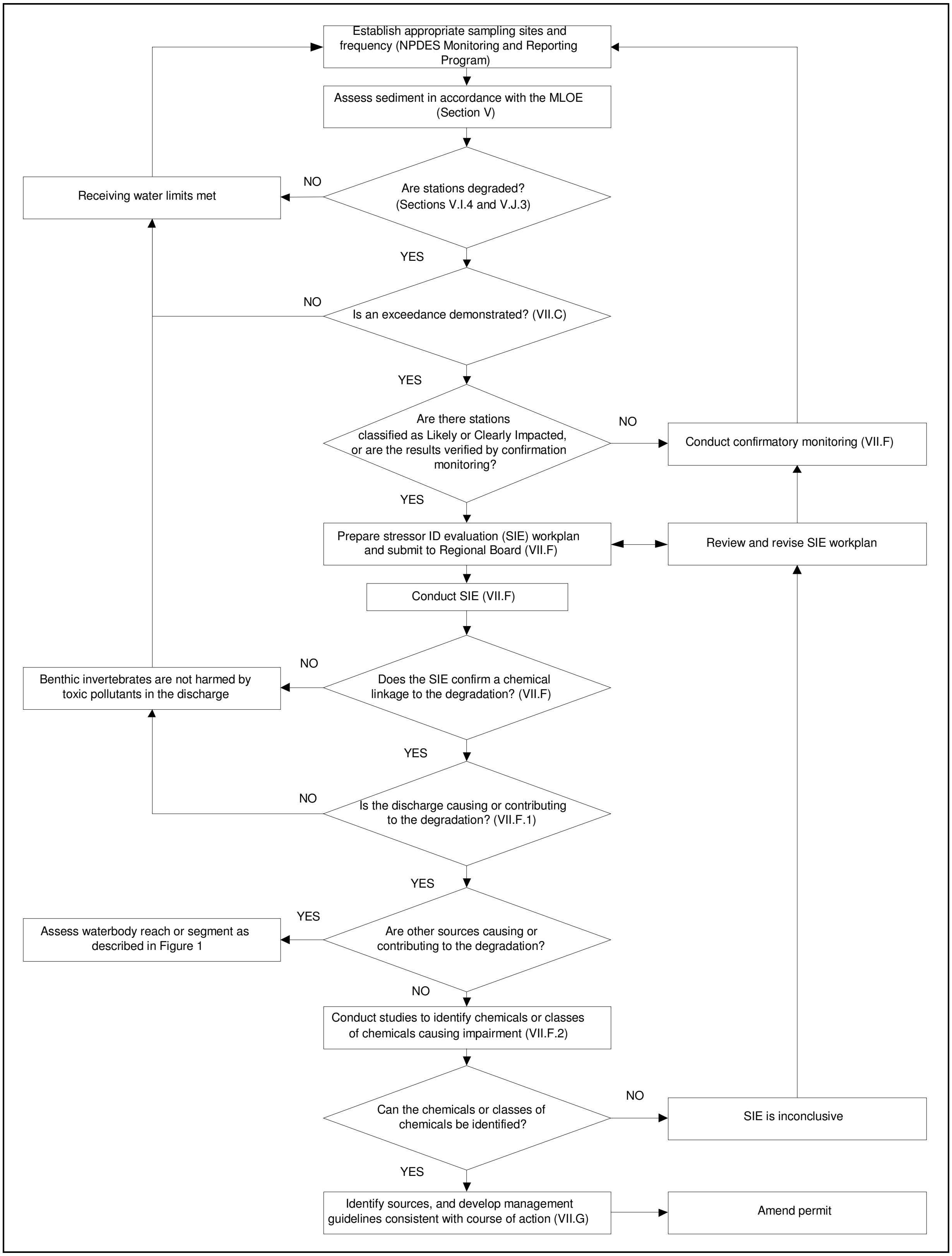

Figure 2. Point Source Assessment Process

Attachment A. List of chemical analytes needed to characterize sediment contamination exposure and effect.

Chemical Name	Chemical Group	Chemical Name	Chemical Group
Total Organic Carbon	General	Alpha Chlordane	Pesticide
Percent Fines	General	Gamma Chlordane	Pesticide
		Trans Nonachlor	Pesticide
Cadmium	Metal	Dieldrin	Pesticide
Copper	Metal	o,p’-DDE	Pesticide
Lead	Metal	o,p’-DDD	Pesticide
Mercury	Metal	o,p’-DDT	Pesticide
Zinc	Metal	p,p’-DDD	Pesticide
		p,p’-DDE	Pesticide
		p,p’-DDT	Pesticide
Acenaphthene	PAH	2,4'-Dichlorobiphenyl	PCB congener
Anthracene	PAH	2,2',5-Trichlorobiphenyl	PCB congener
Biphenyl	PAH	2,4,4'-Trichlorobiphenyl	PCB congener
Naphthalene	PAH	2,2',3,5'-Tetrachlorobiphenyl	PCB congener
2,6-dimethylnaphthalene	PAH	2,2',5,5'-Tetrachlorobiphenyl	PCB congener
Fuorene	PAH	2,3',4,4'-Tetrachlorobiphenyl	PCB congener
1-methylnaphthalene	PAH	2,2',4,5,5'-Pentachlorobiphenyl	PCB congener
2-methylnaphthalene	PAH	2,3,3',4,4'-Pentachlorobiphenyl	PCB congener
1-methylphenanthrene	PAH	2,3',4,4',5-Pentachlorobiphenyl	PCB congener
Phenanthrene	PAH	2,2',3,3',4,4'-Hexachlorobiphenyl	PCB congener
Benzo(a)anthracene	PAH	2,2',3,4,4',5'-Hexachlorobiphenyl	PCB congener
Benzo(a)pyrene	PAH	2,2',4,4',5,5'-Hexachlorobiphenyl	PCB congener
Benzo(e)pyrene	PAH	2,2',3,3',4,4',5-Heptachlorobiphenyl	PCB congener
Chrysene	PAH	2,2',3,4,4',5,5'-Heptachlorobiphenyl	PCB congener
Dibenz(a,h)anthracene	PAH	2,2',3,4',5,5',6-Heptachlorobiphenyl	PCB congener
Fluoranthene	PAH	2,2',3,3',4,4',5,6-Octachlorobiphenyl	PCB congener
Perylene	PAH	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	PCB congener
Pyrene	PAH	Decachlorobiphenyl	PCB congener

Attachment B. Station assessment category resulting from each possible MLOE combination

LOE Category Combination	Sediment Chemistry Exposure	Benthic Community Condition	Sediment Toxicity	Station Assessment
1	Minimal	Reference	Nontoxic	Unimpacted
2	Minimal	Reference	Low	Unimpacted
3	Minimal	Reference	Moderate	Unimpacted
4	Minimal	Reference	High	Inconclusive
5	Minimal	Low	Nontoxic	Unimpacted
6	Minimal	Low	Low	Likely unimpacted
7	Minimal	Low	Moderate	Likely unimpacted
8	Minimal	Low	High	Possibly impacted
9	Minimal	Moderate	Nontoxic	Likely unimpacted
10	Minimal	Moderate	Low	Likely unimpacted
11	Minimal	Moderate	Moderate	Possibly impacted
12	Minimal	Moderate	High	Likely impacted
13	Minimal	High	Nontoxic	Likely unimpacted
14	Minimal	High	Low	Inconclusive
15	Minimal	High	Moderate	Possibly impacted
16	Minimal	High	High	Likely impacted
17	Low	Reference	Nontoxic	Unimpacted
18	Low	Reference	Low	Unimpacted
19	Low	Reference	Moderate	Likely unimpacted
20	Low	Reference	High	Possibly impacted
21	Low	Low	Nontoxic	Unimpacted
22	Low	Low	Low	Likely unimpacted
23	Low	Low	Moderate	Possibly impacted
24	Low	Low	High	Possibly impacted
25	Low	Moderate	Nontoxic	Likely unimpacted
26	Low	Moderate	Low	Possibly impacted
27	Low	Moderate	Moderate	Likely impacted
28	Low	Moderate	High	Likely impacted
29	Low	High	Nontoxic	Likely unimpacted
30	Low	High	Low	Possibly impacted
31	Low	High	Moderate	Likely impacted
32	Low	High	High	Likely impacted
33	Moderate	Reference	Nontoxic	Unimpacted
34	Moderate	Reference	Low	Likely unimpacted
35	Moderate	Reference	Moderate	Likely unimpacted
36	Moderate	Reference	High	Possibly impacted
37	Moderate	Low	Nontoxic	Unimpacted
38	Moderate	Low	Low	Possibly impacted
39	Moderate	Low	Moderate	Possibly impacted
40	Moderate	Low	High	Possibly impacted
41	Moderate	Moderate	Nontoxic	Possibly impacted
42	Moderate	Moderate	Low	Likely impacted
43	Moderate	Moderate	Moderate	Likely impacted
44	Moderate	Moderate	High	Likely impacted

LOE Category Combination	Sediment Chemistry Exposure	Benthic Community Condition	Sediment Toxicity	Station Assessment
45	Moderate	High	Nontoxic	Possibly impacted
46	Moderate	High	Low	Likely impacted
47	Moderate	High	Moderate	Likely impacted
48	Moderate	High	High	Likely impacted
49	High	Reference	Nontoxic	Likely unimpacted
50	High	Reference	Low	Likely unimpacted
51	High	Reference	Moderate	Inconclusive
52	High	Reference	High	Likely impacted
53	High	Low	Nontoxic	Likely unimpacted
54	High	Low	Low	Possibly impacted
55	High	Low	Moderate	Likely impacted
56	High	Low	High	Likely impacted
57	High	Moderate	Nontoxic	Likely impacted
58	High	Moderate	Low	Likely impacted
59	High	Moderate	Moderate	Clearly impacted
60	High	Moderate	High	Clearly impacted
61	High	High	Nontoxic	Likely impacted
62	High	High	Low	Likely impacted
63	High	High	Moderate	Clearly impacted
64	High	High	High	Clearly impacted

CALIFORNIA

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Arnold Schwarzenegger, Governor

California Environmental Protection Agency
Linda S. Adams, Secretary

State Water Resources Control Board
Charles R. Hoppin, Chair

APPENDIX H:

ATTACHMENT A TO RESOLUTION NO. R11-008

Attachment A to Resolution No. R11-008

Amendment to the Water Quality Control Plan – Los Angeles Region

to Incorporate the

Total Maximum Daily Load for Toxic Pollutants in Dominguez Channel and Greater Los Angeles and Long Beach Harbor Waters

Adopted by the California Regional Water Quality Control Board, Los Angeles Region on May 5, 2011

Amendments

Table of Contents

Add:

List of Figures, Tables, and Inserts

Add:

Chapter 7. Total Maximum Daily Loads (TMDLs)

Dominguez Channel and Greater Los Angeles and Long Beach Harbor Waters Toxic Pollutants TMDL

This TMDL was adopted by:
The Regional Water Quality Control Board on **May 5, 2011.**

This TMDL was approved by:
The State Water Resources Control Board on **[Insert date].**
The Office of Administrative Law on **[Insert date].**
The U.S. Environmental Protection Agency on **[Insert date].**
This TMDL is effective on **[Insert date].**

The elements of the TMDL are presented in Table 7-40.1 and the Implementation Plan in Table 7-40.2.

7-40.1 Dominguez Channel and Greater Los Angeles and Long Beach Harbor Waters Toxic Pollutants TMDL – Elements

TMDL Element	Regulatory Provisions
Problem Statement	The waters of Dominguez Channel and the Greater Los Angeles and Long Beach Harbor area[1] are impaired by heavy metals and organic pollutants. These water bodies are included on the State's Clean Water Act 303(d) impaired waters list for one or more of the following pollutants: cadmium, chromium, copper, mercury, lead, zinc, chlordane, dieldrin, toxaphene, DDT, PCBs, certain PAH compounds, benthic community effects and toxicity. These impairments exist in one or more environmental media—water, sediment, or tissue. Impairments in fish tissue are for DDT, PCBs, toxaphene, chlordane and dieldrin. Beneficial uses designated in these waters to protect aquatic life include the marine habitat use (MAR) and rare, threatened or endangered species habitat use (RARE). In addition, the estuaries (EST) are recognized as areas for spawning, reproduction and/or early development (SPWN), migration of aquatic organisms (MIGR), and wildlife habitat (WILD). Dominguez Channel also has an existing designated use of warm freshwater habitat (WARM) and the Los Angeles River Estuary has the designated use of wetland habitat (WET). Beneficial uses associated with human use of these waters include recreational use for water contact (REC1), non-contact water recreation (REC2), industrial service supply (IND), navigation (NAV), commercial and sport fishing (COMM), and shellfish harvesting (SHELL). Because of the impairments, these waterbodies fail to fully support the designated beneficial uses. The goal of this TMDL is to protect and restore fish tissue, water and sediment quality in Dominguez Channel and Greater Los Angeles and Long Beach Harbor waters by remediating contaminated sediment and controlling the sediment loading and accumulation of contaminated sediment in the Harbors.
Numeric Targets	Applicable water quality objectives for this TMDL are narrative objectives for Chemical Constituents, Bioaccumulation, Pesticides, and Toxicity in the Basin Plan and the numeric water quality criteria promulgated in 40 CFR section 131.38 (the California Toxics Rule (CTR)). In addition, sediment condition objectives were determined using the State Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1 Sediment Quality (SQO Part 1) and the sediment quality guidelines.[2] The following tables provide the water, sediment and fish tissue targets for the Dominguez Channel and Greater Los Angeles and Long Beach Harbor Waters Toxic Pollutants TMDLs. **<u>Water Column Targets</u>** Water targets were determined by this Basin Plan and the California Toxics Rule (CTR). Site-specific conversion factors were developed to convert CTR acute dissolved metal criteria to total recoverable metals using *The Metals Translator Guidance for Calculating a Total Recoverable Permit Limit From a Dissolved Criterion* EPA 823-B-96-007. Because exceedances of CTR criteria were only observed in freshwaters of the Dominguez

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[1] Dominguez Channel includes the Dominguez Channel Estuary and Torrance Lateral Channel and Greater Los Angeles/Long Beach Harbor waters include Inner and Outer Harbor, Main Channel, Consolidated Slip, Southwest Slip, Fish Harbor, Cabrillo Marina, Inner Cabrillo Beach, Los Angeles River Estuary, and San Pedro Bay.

TMDL Element	Regulatory Provisions

Channel during wet weather, targets are set for wet weather only. Site-specific wet-weather conversion factors were calculated using paired dissolved and total metals data and the statistical method outlined in the Guidance.

Dissolved Metals and Organic Compounds Targets

Pollutant	Criteria for the Protection of Aquatic Life (µg/L)				Criteria for Protection of Human Health (µg/L) For consumption of:
	Freshwater		Saltwater		Organisms only
	Acute	Chronic	Acute	Chronic	
Dissolved Metals					
Copper	6.99*	4.95*	4.8	3.1	-
Lead	30.14*	1.17*	210	8.1	-
Zinc	65.13*	65.66*	90	81	-
Mercury	-	-	-	-	0.051
Organic Compounds					
Chlordane	n/a	n/a	0.09	0.004	0.00059
4,4'-DDT	1.1	0.001	0.13	0.001	0.00059
Total PCBs	-	0.014	-	0.03	0.00017
Benzo[a]pyrene**	-	-	-	-	0.049
Dieldrin	0.24	0.056	0.71	0.0019	0.00014

*Freshwater aquatic life criteria for Cu, Pb and Zn are expressed as a function of total hardness (mg/L) in the water body. Values presented correspond to median hardness from 2002 to 2010 of 50 mg/L based upon Los Angeles County Department of Public Works data from Station ID S28 (n = 35).
- means that no criteria were established for California.

**CTR human health criteria were not established for total PAHs. Therefore, the CTR criteria for individual PAHs of 0.049 µg/L are applied individually to benzo(a)pyrene, benzo(a)anthracene, and chrysene. The CTR human health criterion for Pyrene is 11,000 µg/L. Other PAH compounds in the CTR shall be screened as part of the TMDL monitoring.

Total Recoverable Metals, Freshwater Targets

Metal	Acute Dissolved CTR Criteria	Conversion Factor*	Acute Total Recoverable Metals
Copper	6.99	0.722	9.7
Lead	30.14	0.706	42.7
Zinc	65.13	0.935	69.6

* Site-specific conversion factors were calculated using Los Angeles County Department of Public Works data from Station ID S28 using the data record 2002-2010 (n = 35), which had a median hardness of 50 mg/L. Site-specific conversion factors maybe recalculated based on updated data at the time of permit issuance, modification, or renewal.

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[2] Long, ER, LJ Field and DD MacDonald. 1998. *Predicting Toxicity in Marine Sediments with Numerical Sediment Quality Guidelines*, *Environ. Toxicol. Chem.* **17**:4, 714-727. MacDonald, DD, CG Ingersoll and TA Berger. 2000. *Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems*. Arch. Environ. Contam. Toxicol. **39**:20-31.

TMDL Element	Regulatory Provisions

Freshwater toxicity target: This TMDL also establishes a numeric toxicity target of 1.0 toxicity unit, chronic (1.0 TUc) to address toxicity.

TU_c = Toxicity Unit, chronic = 100/NOEC (no observable effects concentration)

Targets based on new toxicity criteria that achieve the narrative Toxicity objective of Chapter 3 of this Basin Plan may substitute for the TU_c of 1, when those new criteria are adopted and in effect.

Sediment Targets

Sediment targets were determined by the narrative standards of this Basin Plan, the SQO Part 1 and the sediment quality guidelines of Long et al. (1998) and MacDonald et al. (2000), which are recommended by the State Listing Policy. The fresh water sediment numeric targets for Dominguez Channel are based on the freshwater Threshold Effect Concentration (TEC) sediment guidelines compiled by the National Oceanic and Atmospheric Administration (NOAA) in the Screening Quick Reference Tables (SQuiRTs). The marine sediment quality guidelines of Effect Range Low (ERL), also from NOAA SQuiRTs, were used to establish the numeric targets for marine sediment for the greater Los Angeles and Long Beach Harbor waters. These TECs and ERLs are set as the sediment quality thresholds for the calculation of loading capacity and allocations. This TMDL anticipates that revisions to specific sediment quality targets may be determined by development of site-specific sediment quality values (SQV).

Sediment targets

Metals	**Freshwater Sediment (mg/kg)**	**Marine Sediment (mg/kg)**
Cadmium	n/a	1.2
Copper	31.6	34
Lead	35.8	46.7
Mercury	n/a	0.15
Zinc	121	150
Chromium	n/a	81
Organics	**Marine Sediment (µg/kg)**	
Chlordane, total	0.5	
Dieldrin	0.02	
Toxaphene	0.10*	
Total PCBs	22.7	
Benzo[a]anthracene	261	
Benzo[a]pyrene	430	
Chrysene	384	
Pyrene	665	
2-methylnaphthalene	201	
Dibenz[a,h]anthracene	260	
Phenanthrene	240	

TMDL Element	Regulatory Provisions

Hi MW PAHs	1700
Lo MW PAHs	552
Total PAHs	4,022
Total DDT	1.58

*Toxaphene value from *Technical Guidance for Screening Contaminated Sediments*, New York State, Department of Environmental Conservation, Division of Fish, Wildlife and Marine Resources (1999), assumes 1% TOC.
n/a indicates that a fresh water sediment target is not established in this TMDL for this constituent, since impairments for the constituent is in saltwater only.

These sediment targets are not intended to be used as ‘clean-up standards’ for navigational, capital or maintenance dredging or capping activities; rather they are long-term sediment concentrations that should be attained after reduction of external loads, targeted actions addressing internal reservoirs of contaminants, and environmental decay of contaminants in sediment. In addition, the categories designated in the SQO Part 1 as **Unimpacted** and **Likely Unimpacted** by the interpretation and integration of multiple lines of evidence shall be considered as the protective narrative objective for sediment toxicity and benthic community effects. The thresholds established in the SQO Part 1 are based on statistical significance and magnitude of the effect. Therefore, this TMDL implicitly includes sediment toxicity and benthic community targets by its use of the SQO Part 1.

<u>Fish Tissue and Associated Sediment Targets</u>

Fish tissue targets were determined from *Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Chlordane, DDTs, Dieldrin, Methylmercury, PCBs, Selenium, and Toxaphene*, developed by OEHHA (2008) to assist agencies in developing fish tissue-based criteria for pollution mitigation or elimination and to protect humans from consumption of contaminated fish. Associated sediment targets required to achieve the fish tissue targets were determined from several sources depending on the contaminant.

Fish Tissue and Associated Sediment Targets

Pollutant	Fish Tissue Target (μg/kg wet)	Associated Sediment Target (μg/kg dry)
Chlordane	**5.6**	**1.3**[b]
Dieldrin	**0.46**	**n/a**
Total DDT	**21**	**1.9**[b]
Total PCBs	**3.6**	**3.2**[c]
Total PAHs	**5.47**[a]	**n/a**
Toxaphene	**6.1**	**0.1**[d]

[a] Total PAHs in fish from EPA screening value.

[b] Chlordane and total DDT associated sediment values from SFEI (2007) “Indicator development and framework for assessing indirect effects of sediment contaminants”, SFEI Contribution #524.

[c] Total PCBs - associated sediment target from Gobas, F. and J. Arnot (2010) “Food Web Bioaccumulation Model for Polychlorinated Biphenyls in San Francisco Bay, California, USA”, ET&C **29**:6, 1385-95.

[d] Toxaphene value from New York State (1999), assumes 1% TOC.

n/a indicates that an associated sediment target is not established in this TMDL at this time because there is no BSAF in literature to use in the calculation. If BSAFs are developed in the future, associated sediment targets for dieldrin and/or PAHs may be added during reconsideration of the TMDL.

Source Analysis	Monitoring data from NPDES discharges and land use runoff coefficients were used to estimate the magnitude of metals, organo-chlorine pesticides, PCBs, and PAHs loads to Dominguez

TMDL Element	Regulatory Provisions
	Channel and Greater Los Angeles and Long Beach Harbor waters. PCBs, DDT, dieldrin, and chlordane are legacy pollutants for the most part, yet, they remain present in the environment, bound to fine-grained particles. Because they are legacy pollutants and are subject to environmental decay, their concentrations are gradually decreasing over time. When these particles become waterborne, the chemicals are ferried to new locations. Urban runoff and rainfall higher in the watersheds mobilize the particles, which are then washed into storm drains and channels that discharge to the Dominguez Channel and greater Harbor waters. Metals and PAHs are currently generated or deposited in the watersheds and are then washed into storm drains and channels that discharge to the Dominguez Channel and greater Harbor waters. Briefly there are several categories of pollutant sources to the waters of concern in these TMDLs. Point sources include stormwater and urban runoff (MS4) and other NPDES discharges, including but not limited to Port operations, Terminal Island Water Reclamation Plant (TIWRP), refineries, and generating plants. Nonpoint sources include existing contaminated sediments and direct (air) deposition. **Dominguez Channel waters:** The major point sources of organo-chlorine pesticides, PCBs, and metals into Dominguez Channel are stormwater and urban runoff discharges. Nonpoint sources include atmospheric deposition and fluxes from contaminated sediments into the overlying water. Current loads of metals into Dominguez Channel were estimated using Loading Simulation Program in C++ (LSPC) model output from simulated flows for 1995-2005. Monitoring data from NPDES discharges and land use runoff coefficients were analyzed along with Channel stream flow rates to estimate the magnitude of metal loadings. In recognition of the wide variety of stream flow rates generated by various rainfall conditions, flow duration curves were utilized to analyze the metals loading during wet weather. **Greater Los Angeles and Long Beach Harbor waters:** A variety of activities over the past decades in the four contributing watersheds (Dominguez Channel, Los Angeles River, San Gabriel River and the nearshore watershed) and in the Harbors themselves have contributed to the sediment contamination. The contaminated sediments are a reservoir of historically deposited pollutants. Stormwater runoff from manufacturing, military facilities, fish processing plants, wastewater treatment plants, oil production facilities, and shipbuilding or repair yards in both Ports discharged untreated or partially treated wastes into Harbor waters. Current activities also contribute pollutants to Harbor sediments. In particular, stormwater runoff from port facilities, commercial vessels (ocean going vessels and harbor craft), recreational vessels, and the re-suspension of contaminated sediments via natural processes and/or anthropogenic activities including (ship) propeller wash within the Ports also contributes to transport of pollutants within the Harbors. Loadings from the four contributing watersheds are also potential sources of metals, pesticides, PCBs, and PAHs to the Harbors. The major nonpoint source of pesticides and PCBs to the greater Harbor waters is the current sediments. The re-suspension of these sediments contributes to the fish tissue impairments. In addition, atmospheric deposition may be a potential nonpoint source of metals to the watershed, through either direct deposition or indirect deposition.

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	Current loading of metals, PAHs, DDT and PCBs to contaminated sediments within the Dominguez Channel Estuary and Greater Harbor waters was estimated using monitoring data from special studies and water body surface area for air deposition; discharge results for refineries and TIWRP; and Environmental Fluid Dynamics Code (EFDC) model output for 2002-2005. Model inputs included the existing average sediment concentration in the top 5 cm of bed sediments and the total sediment deposition rate per waterbody.
Linkage Analysis	The linkage analysis connects pollutant loads to the numeric targets and protection of beneficial uses of Dominguez Channel and Greater Los Angeles and Long Beach Harbor waters. To represent the linkage between source contributions and ambient water and sediment response, two dynamic water quality models were developed to simulate source loadings and transport of the listed pollutants in Dominguez Channel and Greater Los Angeles and Long Beach Harbor waters. The Environmental Fluid Dynamics Code (EFDC) and Loading Simulation Program in C++ (LSPC) models were selected to simulate the pollutants in this TMDL.

LSPC for freshwater loadings of metals and total PAHs, DDT, and PCBs. LSPC was developed for Dominguez Channel based on information initially provided by SCCWRP for this watershed. In addition, Los Angeles River and San Gabriel River LSPC models were updated from earlier TMDL models. Model development throughout the Los Angeles Region relies on Event Mean Concentrations (EMC) as well as simulated flows to estimate pollutant loadings. Flow data records for 1995-2005 were used to calibrate LSPC models for each watershed; similar simulation time frames were used to generate simulated flows for each watershed. Dominguez Channel freshwater metals TMDLs examined only wet weather flows; however, LSPC output for dry and wet weather conditions was applied to all estuarine and marine receiving waters.

The nearshore watershed was analyzed and modeled using LSPC by breaking it into 67 subwatersheds that discharge directly to the Greater Los Angeles and Long Beach Harbor waters. These sub-watersheds were then aggregated by receiving waterbody; e.g. nearshore contributions to Inner Harbor consisted of stormdrains and surface (sheet) flows that discharge directly into the Inner Harbor.

The table below shows total loads from the four contributing watersheds to the Greater Harbor waters. Overall, the Los Angeles River is the largest freshwater contributor of pollutants to the greater Harbor waters; flows from the Los Angeles River primarily impact water quality in eastern San Pedro Bay. The Inner Harbor receives the bulk of the loading from the nearshore watershed.

Comparative Watershed Loading to Greater Harbor Waters

	LSPC Modeled Existing Loading by Watershed (1995-2005)							
	Dominguez Channel		**Los Angeles River**		**San Gabriel River**		**Nearshore Watershed**	
Contaminant	**Percent of Total Loading**	**Average Daily Load (kg/day)**	**Percent of Total Loading**	**Average Daily Load (kg/day)**	**Percent of Total Loading**	**Average Daily Load (kg/day)**	**Percent of Total Loading**	**Average Daily Load (kg/day)**
Wet Conditions								
Sediment	5.6%	1.88E+05	72.0%	2.79E+06	20.4%	4.90E+05	1.9%	6.54E+04
Total Copper	4.3%	3.58E+01	81.1%	7.85E+02	12.5%	7.51E+01	2.1%	1.78E+01
Total Lead	3.0%	2.08E+01	71.5%	5.67E+02	23.3%	1.15E+02	2.2%	1.53E+01

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Total Zinc	5.0%	3.56E+02	72.2%	5.89E+03	20.2%	1.02E+03	2.6%	1.84E+02
Total DDT	9.2%	2.20E-02	89.5%	2.46E-01	0.7%	1.15E-03	0.7%	1.59E-03
Total PAH	8.0%	2.04E+00	70.2%	2.07E+01	16.1%	2.95E+00	5.8%	1.50E+00
Total PCB	2.3%	1.38E-02	97.5%	6.86E-01	0.1%	3.11E-04	0.2%	9.92E-04
Dry Conditions								
Sediment	0.7%	8.57E+01	19.0%	2.27E+03	80.1%	1.01E+04	0.1%	1.54E+01
Total Copper	2.6%	2.56E-01	48.7%	4.69E+00	40.8%	4.18E+00	8.0%	7.78E-01
Total Lead	0.9%	3.48E-02	19.8%	7.86E-01	72.9%	3.07E+00	6.5%	2.59E-01
Total Zinc	0.9%	5.65E-01	30.4%	1.90E+01	62.6%	4.15E+01	6.2%	3.89E+00
Total DDT	7.7%	1.90E-05	83.0%	2.01E-04	9.3%	2.38E-05	0.0%	2.88E-10
Total PAH	6.8%	7.06E-02	62.7%	6.39E-01	30.4%	3.29E-01	0.0%	4.18E-05
Total PCB	1.8%	1.06E-05	97.1%	5.59E-04	1.1%	6.43E-06	0.0%	1.45E-10

The EFDC was used to model hydrodynamics and water and sediment quality of the greater Los Angeles and Long Beach Harbor waters. The EFDC model applied a simulated time period of 2002-2005. The model was calibrated with numerous sediment monitoring studies, including Los Angeles and Long Beach Harbor's 2006 sediment characterization study, which yielded sediment, porewater and overlying water concentrations as well as results from highly sensitive monitoring devices for detecting DDT, PCBs, and PAHs in the water column. The EFDC model also considered ocean water (outside breakwater) conditions and fine and coarse sediment transport and deposition. Ultimately the EFDC model was integrated with LSPC output – hourly for three watersheds, daily for nearshore watersheds – to model metals, PAHs, PCBs, and DDT (total) sediment concentrations in the receiving waters. The annual total (clean) sediment deposition rate for the top 5 cm (active sediment layer) was multiplied by the corresponding existing sediment pollutant level or the TMDL sediment quality target to yield pollutant load within each waterbody.

Annual (clean) Sediment Deposition Rates per (salt)Waterbody

Waterbody Name	TMDL Zone	Area (acres)[1]	Area (m^2)[1]	Total Deposition (kg/yr)[2]
Dominguez Channel Estuary	01	140	567,900	2,470,201
Consolidated Slip	02	36	147,103	355,560
Inner Harbor - POLA	03	1,539	6,228,431	1,580,809
Inner Harbor - POLB	08	1,464	5,926,130	674,604
Fish Harbor	04	91	368,524	30,593
Cabrillo Marina	05	77	310,259	38,859
Cabrillo Beach	06	82	331,799	27,089
Outer Harbor - POLA	07	1,454	5,885,626	572,349
Outer Harbor - POLB	09	2,588	10,472,741	1,828,407
Los Angeles River Estuary	10	207	837,873	21,610,283
San Pedro Bay	11	8,173	33,073,517	19,056,271

[1] Area obtained from GIS layer of the 2006 303(d) list. Available at: http://www.waterboards.ca.gov/water_issues/programs/tmdl/303d_lists2006_gis.shtml

[2] Sediment deposition rates were calculated by approximating the average mass of total sediment (fine and coarse particles) deposited in each waterbody annually based on 2002-2005 EFDC output. Sediment flux for each grid cell,

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	which is dependent on watershed inputs as well as tidal movements between waterbodies, was obtained from the EFDC model output. These values were summarized across each TMDL waterbody, resulting in the average deposition of both sediment fines and sand by waterbody. The total deposition rate is simply the sum of the rates for fines and sand and this value is the waterbody-specific average annual (clean) sediment deposition rate. The EFDC model was used to evaluate several management scenarios and relative contributions from various inputs to support water quality management decisions in Dominguez Channel and Greater Los Angeles and Long Beach Harbor waters. Preliminary results for two scenarios indicate that reducing freshwater input loads may not be sufficient to achieve target concentrations in water and sediments; thus reductions in contaminant levels in bed sediments may be required.
Loading Capacity	Loading capacity was calculated for both Dominguez Channel (wet weather) and in the Dominguez Channel Estuary and Greater Harbor waters (dry and wet weather). Dominguez Channel wet weather metals TMDLs: During wet weather, the loading capacity is a function of the volume of water in the Channel. Given the variability in wet-weather flows, the concept of a single critical flow was not justified. Instead, a load duration curve approach was used to establish the wet-weather loading capacity. The load duration curve was developed by multiplying the wet-weather flows by the in-stream numeric targets. The resulting curves identify the allowable load for a given flow. The wet-weather TMDLs for copper and zinc are defined by these load duration curves. Loading capacities were calculated by multiplying the daily volume by the appropriate numeric water quality target or, in the case of lead, the observed existing average concentration. The wet-weather loading capacity applies to any day when the maximum daily flow measured at a location within the Dominguez Channel is equal to or greater than 62.7 cfs, which is the 90th percentile of annual flow rates from estimated/modeled flow rates. The freshwater toxicity TMDL is equal to 1 TUc. Dominguez Channel Estuary and Greater Harbor waters, metals and organics in sediment TMDLs: Loading capacities for Dominguez Channel Estuary and Greater Harbor waters were calculated by estimating the sediment load (based on modeled sediment deposition rates) multiplied by the sediment quality target. The active sediment layer was defined as the top 5 cm of sediment; the habitat of approximately 95% of benthic organisms. In addition, chlordane, dieldrin, toxaphene and mercury TMDLs were defined for specific waterbodies as equivalent to the concentration-based sediment quality target.
Waste Load and Load Allocations	Final waste load allocations (WLA) are assigned to stormwater dischargers (MS4, California Department of Transportation (Caltrans), general construction and general industrial dischargers), and other NDPES dischargers. Final load allocations (LAs) are assigned to direct atmospheric deposition and bed sediments in both wet and dry weather. Dominguez Channel freshwater allocations are set for wet weather only because exceedances have only been observed in wet weather. Mass-based allocations have been set where sufficient data was available to calculate mass-based allocations, otherwise, concentration-based allocations have

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	been set.

Interim WLA and LA are intended to not allow any decrease in current facility performance. Interim allocations shall be met upon the effective date of the TMDL.

Interim and final WLAs and LAs shall be included in permits and/or other Board orders in accordance with state and federal regulations and guidance.

INTERIM ALLOCATIONS

1. Dominguez Channel Freshwater Interim Allocations

A. Freshwater Toxicity Interim Allocation wet weather

An interim allocation of 2 TUc applies to each source, including all point sources assigned a WLA and all nonpoint sources assigned a LA. The freshwater toxicity interim allocation is set at 2 TUc based on current monitoring results performed by the Los Angeles County Department of Public Works, which have shown average values of less than 2 TUc. The fresh water interim allocation shall be implemented as a trigger requiring initiation and implementation of the TRE/TIE process as outlined in US EPA's "Understanding and Accounting for Method Variability in Whole Effluent Toxicity Applications Under the National Pollutant Discharge Elimination System Program" (2000) and current NPDES permits. The fresh water interim allocation shall be implemented in accordance with US EPA, State Board and Regional Board resolutions, guidance and policy at the time of permit issuance, modification or renewal.

B. Freshwater Metals Interim Allocations - wet weather only

Interim water allocations are assigned to stormwater dischargers (MS4, Caltrans, general construction and general industrial stormwater dischargers) and other NPDES dischargers. Interim water allocations are based on the 95th percentile of total metals data collected from January 2006 to January 2010 using a log-normal distribution. The use of 95th percentile values to develop interim allocations is consistent with NPDES permitting methodology. Regardless of the interim allocations below, permitted dischargers shall ensure that effluent concentrations and mass discharges do not exceed levels that can be attained by performance of the facility's treatment technologies existing at the time of permit issuance, reissuance or modification.

Concentration-based Dominguez Channel and Torrance Lateral freshwater interim metal allocations

	Total Copper	Total Lead	Total Zinc
allocation (μg/L)	207.51	122.88	898.87

2. Dominguez Channel Estuary and Greater Los Angeles and Long Beach Harbor Waters:

Interim sediment allocations are assigned to stormwater dischargers (MS4, Caltrans, general construction and general industrial stormwater dischargers) and other NPDES dischargers. Interim sediment allocations are based on the 95th percentile of sediment data collected from 1998-2006. The use of 95th percentile values to develop interim allocations is consistent with NPDES permitting methodology. For waterbodies where the 95th percentile value has been equal to, or lower than, the numeric target, then the interim allocation is set equal to the final allocation. Regardless of the interim sediment allocations below, permitted dischargers shall

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ensure that effluent concentrations and mass discharges do not exceed levels that can be attained by performance of the facility's treatment technologies existing at the time of permit issuance, reissuance or modification.

Sediment, interim concentration-based allocations

Waterbody	Pollutant (mg/kg sediment)					
	Copper	**Lead**	**Zinc**	**DDT**	**PAHs**	**PCBs**
Dominguez Channel Estuary	220.0	510.0	789.0	1.727	31.60	1.490
Long Beach Inner Harbor	142.3	50.4	240.6	0.070	4.58	0.060
Los Angeles Inner Harbor	154.1	145.5	362.0	0.341	90.30	2.107
Long Beach Outer Harbor (inside breakwater)	67.3	**46.7**	**150**	0.075	**4.022**	0.248
Los Angeles Outer Harbor (inside breakwater)	104.1	**46.7**	**150**	0.097	**4.022**	0.310
Los Angeles River Estuary	53.0	**46.7**	183.5	0.254	4.36	0.683
San Pedro Bay Near/Off Shore Zones	76.9	66.6	263.1	0.057	**4.022**	0.193
Los Angeles Harbor - Cabrillo Marina	367.6	72.6	281.8	0.186	36.12	0.199
Los Angeles Harbor - Consolidated Slip	1470.0	1100.0	1705.0	1.724	386.00	1.920
Los Angeles Harbor - Inner Cabrillo Beach Area	129.7	**46.7**	163.1	0.145	**4.022**	0.033
Fish Harbor	558.6	116.5	430.5	40.5	2102.7	36.6

Numbers in **bold** are also the final allocation.

Compliance with the interim concentration-based sediment allocations may be demonstrated via any one of three different means:

1. Demonstrate that the sediment quality condition of **Unimpacted** or **Likely Unimpacted** via the interpretation and integration of multiple lines of evidence as defined in the SQO Part 1, is met; or
2. Meet the interim allocations in bed sediment over a three-year averaging period; or
3. Meet the interim allocations in the discharge over a three-year averaging period.

FINAL ALLOCATIONS

1. Dominguez Channel Freshwater Allocations

A. <u>Freshwater Toxicity Allocation</u> in wet weather

A final allocation of 1 TUc, or its equivalent based on any Statewide Toxicity Policy, applies to each source, including all point sources assigned a WLA and all nonpoint sources assigned a LA.

B. <u>Freshwater Metals Allocations in wet weather</u>

Wet-weather allocations are assigned to Dominguez Channel and all upstream reaches and tributaries of Dominguez Channel (above Vermont Avenue).

Allocations are assigned to both point (WLA) and nonpoint sources (LA). A mass-based LA has been developed for direct atmospheric deposition. A mass-based waste load allocation (WLA) is divided between the MS4 permittees and Caltrans under its NPDES stormwater

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permit by subtracting the other stormwater or NPDES waste load allocations, air deposition and the margin of safety from the total loading capacity. Concentration-based WLAs are assigned for the other point sources including but not limited to General Construction, General Industrial, Power Generating stations, minor permits and irregular dischargers, and other NPDES dischargers.

Mass-based Dominguez Channel Wet-weather Final Allocations

	Total Copper (g/day)	Total Lead (g/day)	Total Zinc (g/day)
TMDL	1,485.1	6,548.8	10,685.5
Waste Load Allocations:			
MS4 – LA County Permittees	1,300.3	5,733.7	9,355.5
MS4 - Caltrans	32.3	142.6	232.6
Load Allocations:			
Air Deposition	4.0	17.7	28.9
Margin of Safety			
MOS (10%)	148.5	654.9	1,069.6

Based on total recoverable metal targets, a hardness of 50 mg/L, and 90th percentile of annual flow rates (62.7 cfs) in Dominguez Channel. Recalculated mass-based allocations using ambient hardness and flow rate at the time of sampling are considered consistent with the assumptions and requirements of these waste load allocations. In addition to the wasteload allocations above, samples collected during flow conditions less than the 90th percentile of annual flow rates must demonstrate that the acute and chronic hardness dependent water quality criteria provided in the CTR are achieved.

Concentration-based Dominguez Channel Wet-weather Final Allocations (µg/L)

	Total **Copper**	Total **Lead**	Total **Zinc**
Other stormwater/NPDES	**9.7**	**42.7**	**69.7**

Based on hardness = 50 mg/L. Recalculated concentration-based allocations using ambient hardness at the time of sampling are considered consistent with the assumptions and requirements of these waste load allocations. In addition to the wasteload allocations above, samples collected during flow conditions less than the 90th percentile of annual flow rates must demonstrate that the acute and chronic hardness dependent water quality criteria provided in the CTR are achieved.

2. Torrance Lateral Freshwater and Sediment Allocations

Torrance Lateral is a subwatershed that flows directly into Dominguez Channel Estuary. Allocations are assigned to the ExxonMobil Torrance Refinery and all other dischargers. Mass-based sediment allocations are assigned to the ExxonMobil Torrance Refinery. This allocation has been developed based on an average discharge frequency of once every 7 years. If, at the end of Phase I of implementation, due to an increase in discharge frequency or volumes, it appears that the allocations are not supportive of the TMDL, these allocations may be revised. Sediment waste load allocations are assigned to all other dischargers to Torrance Lateral equal to the concentration-based sediment targets.

Torrance Lateral Wet-weather Waste Load Allocations and Sediment Waste Load Allocations, concentration-based

Media	Total Copper	Total Lead	Total Zinc
Water (unfiltered) (µg/L)	9.7	42.7	69.7
Sediment (mg/kg dry)	31.6	35.8	121

Hardness = 50 mg/L. Recalculated concentration-based allocations using ambient hardness at the time of sampling are considered consistent with the assumptions and requirements of these

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waste load allocations. In addition to the wasteload allocations above, samples collected during flow conditions less than the 90th percentile of annual flow rates must demonstrate that the acute and chronic hardness dependent water quality criteria provided in the CTR are achieved.

Waste Load Allocations for ExxonMobil Torrance Refinery into Torrance Lateral, mass-based

Media	Total Copper	Total Lead	Total Zinc
Water (unfiltered) (kg/yr)	1.36	5.98	9.75

Based on Q = 3.7 MGD for 7 days/year; and total metals targets
No allocation for PAHs is assigned to ExxonMobil; however, discharges should not exceed existing water quality criteria for those compounds and monitoring shall continue.

Compliance with the freshwater metals allocations for Dominguez Channel and Torrance Lateral may be demonstrated via any one of three different means:
a. Final allocations are met.
b. CTR total metals criteria are met instream.
c. CTR total metals criteria are met in the discharge.

Dominguez Channel Estuary and Greater Harbor Waters Allocations

Concentration-based WLAs for point sources in Dominguez Channel Estuary and Greater Harbor Waters (including refineries) for metals, PAHs, and bioaccumulative compounds in water.

Non-MS4 point sources such as General Construction, General Industrial, individual industrial permittees, including power generating stations, minor permits and irregular dischargers into Dominguez Channel Estuary and Greater Harbor Waters are assigned concentration-based allocations. Mass-based WLA for other refineries based on appropriate data maybe considered during the TMDL reconsideration. (Refineries which have provided discharge flow data along with monitoring results are assigned mass-based allocations, whereas other refineries are assigned concentration-based allocations because no discharge flow data has been provided.) Any future minor NPDES permits or enrollees under a general NPDES permit are also assigned the concentration-based waste load allocations. The allocations are set equal to the saltwater targets for metals and equal to the human health targets for the organic compounds in CTR. The averaging period for the concentration-based WLAs shall be consistent with that specified in the regulation establishing the criterion or objective or relevant implementation guidance published by the establishing agency.

Receiving (salt) Water Column Concentration-Based Waste Load Allocations

Constituents	Copper* (µg/L)	Lead* (µg/L)	Zinc* (µg/L)	PAHs (µg/L)	Chlordane (µg/L)	4,4'-DDT (µg/L)	Dieldrin (µg/L)	Total PCBs (µg/L)
Dominguez Channel Estuary	3.73	8.52	85.6	0.049**	0.00059	0.00059	0.00014	0.00017
Greater Harbor Waters	3.73	8.52	85.6			0.00059		0.00017

* Total Concentration-based WLAs for metals are converted from saltwater dissolved CTR criteria using CTR saltwater default translators.

** CTR human health criteria were not established for total PAHs. Therefore, the CTR criterion for individual PAHs of 0.049 µg/L is applied individually to benzo(a)anthracene, benzo(a)pyrene, and chrysene. The CTR criterion for

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	Pyrene of 11,000 µg/L is assigned as an individual WLA to Pyrene. Other PAH compounds in the CTR shall be screened as part of the TMDL monitoring. A. **Mass-based allocations for metals and PAHs compounds** Mass-based WLAs are assigned to the Terminal Island Water Reclamation Plant (TIWRP) (based on current discharge volume) and other point sources that have sufficient discharge flow data. Municipal stormwater sources, including the Los Angeles, Long Beach, Caltrans and other MS4 co-permittees, are assigned a mass-based allocation for each permit in place at the time of TMDL adoption, depending on the waterbody. Discharges from the Port of Los Angeles (POLA) and Port of Long Beach (POLB) are grouped with the MS4 dischargers. Mass-based WLAs are applied as annual limits. Individual mass-based WLAs for an individual MS4 Permittee will be calculated based on its share, on an area basis, of the mass-based WLA or other approved approach available at the time final mass-based WLAs are in effect and incorporated into the permit. TMDLs and allocations were developed based on existing sediment concentrations in the active sediment layer defined herein as the top 5 cm of bed sediment concentrations. Load Allocations are assigned to existing sediments and direct air deposition. All allocations assigned to point sources and non-point sources are subtracted from the loading capacity and the remaining allocatable amount is assigned to the bed sediments. Direct air deposition allocations have been set equal to existing load estimates for Cu, Zn and PAHs based on atmospheric monitoring results collected in 2006. The Pb air deposition allocation has been developed by using the SCAQMD air quality Pb criteria (2010) multiplied by the surface area of each waterbody to produce direct air deposition allocations. Future changes to Cu, Zn and PAH air quality criteria, other regulation such as brake pad requirements, or other improvement in air quality may allow for re-calculations of air deposition allocations in future revisions to the TMDL. If, at some point in the future, a nonpoint source is considered subject to NPDES or WDR regulations, then the corresponding load allocation established herein may be considered a waste load allocation for purposes of implementation and enforcement through a permit or other Board order. Air deposition allocations for copper and zinc are based on existing loads; by assuming no direct deposition reductions, this consumes or partially consumes the available loading capacity. As a result, copper and zinc load allocations for bed sediments are negative values, in Inner and Outer Harbor, indicating that copper and zinc loads must be reduced. (Each negative copper and zinc bed sediment allocation may alternatively be interpreted as zero, or not adversely affecting benthic organisms.) The amount of copper and zinc load reduction may be revised based on future monitoring results. If future air deposition studies show lower existing air deposition copper and zinc loads, or if future copper and zinc sediment characterization studies show lower bed sediment copper and zinc loads, then copper and zinc allocations may be adjusted. The bed sediment LA is assigned to the City of Los Angeles (including the Port of Los Angeles), the City of Long Beach (including the Port of Long Beach) and the State Lands Commission. After remediation activities that address existing sediment contamination are complete and when LAs are attained, if bed sediments are recontaminated as a result of continued polluted discharge from the surrounding watersheds, the WLA compliance monitoring data will be used, along with other available information, to assess the relative contribution of watershed dischargers and determine their responsibility and allocations for secondary remediation activities.

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Final, mass-based TMDLs and Allocations for metals and PAHs (Kg/year)

Waterbody/source	*Total Cu*	*Total Pb*	*Total Zn*	*Total PAHs*
DomCh Estuary - TMDL	84	115.4	370.5	9.94
WLAs				
MS4- LA County et al.	22.4	54.2	271.8	0.134
MS4- City of Long Beach	0.6	1.52	7.6	0.0038
MS4- CalTrans	0.384	0.93	4.7	0.0023
LAs				
Air deposition	4.6	0.031	33.2	0.051
Bed sediments	56.0	58.7	53.3	9.7
Current Load	327.6	457.9	1799.0	28.1
Overall reduction	74%	75%	79%	65%
Consolidated Slip - TMDL	12.1	16.6	53.3	1.43
WLAs				
MS4- LA County et al.	2.73	3.63	28.7	0.0058
MS4 CalTrans	0.043	0.058	0.5	0.00009
LAs				
Air deposition	1.2	0.008	8.6	0.013
Bed sediments	8.13	12.9	15.57	1.41
Current Load	92.1	127.3	398.9	11.5
Overall reduction	***87%***	***87%***	***87%***	***88%***
Inner Harbor - TMDL	76.7	105.3	338.3	9.1
WLAs				
MS4- LA County et al.	1.7	34.0	115.9	0.088
MS4 City of Long Beach	0.463	9.31	31.71	0.024
MS4 CalTrans	0.032	0.641	2.18	0.0017
LAs				
Air deposition	97.6	0.67	710	1.08
Bed sediments	(23.1)	60.7	(521.3)	7.88
Current Load	178.4	105.9	542.1	3.524
Overall reduction	57%	1%	38%	0%
Outer Harbor - TMDL	81.6	112.1	360.1	9.7
WLAs				
MS4- LA County et al.	0.91	26.1	81.5	0.105
MS4 City of Long Beach	0.63	18.1	56.4	0.073
MS4 CalTrans	0.0018	0.052	0.162	0.00021
TIWRP = POTW	80.4	183.6	1845	1.056

TMDL Element	**Regulatory Provisions**				
	(CTR & MGD***)				
	LAs				
	Air deposition ***Bed sediments***	17.9 (18.2)	0.9 (116)	108.1 (1731)	1.5 6.964
	Current Load	119.0	66.7	403.4	0.626
	Overall reduction	31%	0%	11%	0%
	Fish Harbor - TMDL	1.04	1.43	4.59	0.123
	WLAs				
	MS4- LA County et al. (POLA)	0.00017	0.54	1.62	0.007
	MS4 CalTrans	0.0000005	0.00175	0.0053	0.000021
	LAs				
	Air deposition ***Bed sediments***	0.4 0.636	0.02 0.87	2.4 0.5	0.033 0.084
	Current Load	1.43	0.60	4.2	0.003
	Overall reduction	27%	0%	0%	0%
	Cabrillo Marina -TMDL	1.32	1.81	5.8	0.156
	WLAs				
	MS4- LA County et al. (POLA)	0.0196	0.289	0.74	0.00016
	MS4 CalTrans	0.00019	0.0028	0.007	0.0000016
	LAs				
	Air deposition ***Bed sediments***	0.34 1.0	0.017 1.506	2.05 3.03	0.028 0.1285
	Current Load	9.2	2.3	9.14	0.236
	Overall reduction	86%	21%	36%	34%
	San Pedro Bay - TMDL	648	890	2858	76.6
	WLAs				
	MS4- LA County et al.	20.3	54.7	213.1	1.76
	MS4 City of Long Beach	137.9	372.2	1449.7	12.0
	MS4 CalTrans	0.88	2.39	9.29	0.077
	MS4 Orange County**	9.8	26.4	102.9	0.85
	LAs				
	Air deposition ***Bed sediments***	36 442.9	1.8 432	219 865	2.9 59.0
	Current Load	1251	1737	8167	3.63
	Overall reduction	48%	49%	65%	0%
	LA River Estuary - TMDL	735	1009	3242	86.9
	WLAs				
	LAR Estuary dischargers*	[Cu SQV]	[Pb SQV]	[Zn SQV]	[PAH SQV]

TMDL Element	Regulatory Provisions

MS4- LA County et al.	35.3	65.7	242.0	2.31
MS4 City of Long Beach	375.8	698.9	2572.7	24.56
MS4 CalTrans	5.1	9.5	34.8	0.333
LAs				
Air deposition	6.7	0.046	48.9	0.075
Bed sediments	311.8	235.0	343.0	59.6
Current Load	1612	2641	20096	8.72
Overall reduction	54%	62%	84%	0%

Note: Cu and Zn air deposition load allocations are set equal to existing load with no reductions anticipated. Negative (values) for bed sediments indicate that bed sediment loads are expected to be reduced; the amount of reduction may be revised with additional monitoring results.

*SQVs are currently set at ERLs
**Orange County MS4 Permit is issued by the Santa Ana Regional Board. The allocations included, here, for the Seal Beach nearshore area, are for TMDL calculation purposes only, and an allocation is not assigned.
***For TIWRP, the discharge volume at the time of permit modification or reissuance shall be used to calculate the mass-based effluent limitations consistent with the assumptions and requirements of these WLAs. Studies may be conducted to determine the portion of the discharged pollutants that is deposited on bed sediment. The results of any such Executive Officer approved studies shall be evaluated at the TMDL reconsideration to modify these WLAs as appropriate.

Consolidated Slip and Fish Harbor are impaired for mercury in sediments and the average sediment concentration (1.1 mg/kg dry) is significantly higher than the target concentration (0.15 mg/kg dry). Consolidated Slip and Dominguez Channel Estuary are impaired for cadmium in sediments, and Consolidated Slip is also impaired for chromium in sediments.

Final Concentration-Based Sediment WLAs for metals in Dominguez Channel Estuary, Consolidated Slip and Fish Harbor

Concentration-based Sediment WLAs (mg/kg dry sediment)		
Cadmium	Chromium	Mercury
1.2	81	0.15

Mercury applies to both Consolidated Slip and Fish Harbor; Cd applies to Dominguez Channel Estuary and Consolidated Slip, and Cr applies to Consolidated Slip only.

Compliance with these sediment TMDLs for Cu, Pb, Zn, Cd, Cr, Hg and total PAHs may be demonstrated via any one of three different means:

a. Final sediment allocations, as presented above, are met.
b. The qualitative sediment condition of **Unimpacted** or **Likely Unimpacted** via the interpretation and integration of multiple lines of evidence as defined in the SQO Part 1, is met, with the exception of Cr, which is not included in the SQO Part 1.
c. Sediment numeric targets are met in bed sediments over a three-year averaging period.

Compliance with mass-based WLAs shall be measured at designated discharge points. Compliance with concentration-based WLAs for existing sediment shall be determined by pollutant concentrations in ambient sediment in each waterbody. The average ambient bulk sediment level within a waterbody at or below the sediment quality target is considered compliance with these TMDLs.

B. **Mass-based Allocations for Bioaccumulative Compounds**

TMDL Element	Regulatory Provisions
	Fish tissue levels of certain bioaccumulative compounds are above desired numeric targets. These TMDLs are designed to reduce contaminated sediment levels, which will result in lower corresponding pollutant levels in fish tissue. These sediment allocations have been derived to support lowering fish tissue levels using biota-sediment accumulation factors (BSAFs) or ERLs, whichever is more protective. For chlordane and dieldrin, the ERL values are lower and more protective than BSAF values. The DDT sediment values are comparable (ERL = 1.58, BSAF = 1.9); the more stringent one was used for calculation. The PCBs sediment value associated with fish tissue is more stringent than the ERL sediment value for PCBs. Mass-based WLAs are assigned for TIWRP and other point sources that have sufficient discharge flow data. Municipal stormwater sources, including the Los Angeles, Long Beach, Caltrans and other MS4 co-permittees, are assigned a single, mass-based allocation by permit, depending on the waterbody. Discharges from the Port of Los Angeles (POLA) and Port of Long Beach (POLB) are grouped with the MS4 dischargers. Mass-based WLAs are applied as annual limits. Individual mass-based WLAs for an individual MS4 Permittee will be calculated based on its share, on an area basis, of the mass based WLA or other approved approach available at the time final mass-based WLAs are in effect and incorporated into the permit. Mass-based LAs are identified for bed sediments and direct air deposition. Direct air deposition allocations for total DDT are based on estimates of existing loads using atmospheric monitoring results collected close to Los Angeles/Long Beach Harbor at SCAQMD Wilmington Station in 2006. Pollutant-specific air deposition values (DDT = 29 ng/m2/day) were multiplied by the surface area of each waterbody to produce direct deposition allocations. Direct deposition allocations for PCBs are not included since air deposition has been measured to be less than water-to-air fluxes. DDT load allocations for bed sediments are negative values, with the exception of those for the Los Angeles River Estuary, indicating that DDT loads must be reduced. (Each negative DDT bed sediment allocation may alternatively be interpreted as zero, or interpreted as minimal bioaccumulation into the food web.) The amount of DDT load reduction may be revised based on future monitoring results. If future air deposition studies show lower existing air deposition DDT loads, or if future DDT sediment characterization studies show lower bed sediment DDT loads, then DDT load allocations may be adjusted. The Greater Harbor Waters (excluding LA River Estuary and Consolidated Slip) bed sediment LA is assigned to the City of Los Angeles (including the Port of Los Angeles), the City of Long Beach (including the Port of Long Beach) and the State Lands Commission. After remediation activities that address existing sediment contamination are complete and when LAs are attained, if bed sediments are recontaminated as a result of continued polluted discharge from the surrounding watersheds, the WLA compliance monitoring data will be used, along with other available information, to assess the relative contribution of watershed dischargers and determine their responsibility and allocations for secondary remediation activities. DDT and PCBs (total) TMDLs apply to all estuarine and marine waters in Greater Harbor area, including Inner Cabrillo Beach, Los Angeles River Estuary and Eastern San Pedro Bay.

TMDL Element	Regulatory Provisions

Final mass-based TMDLs and Allocations for total DDT and total PCBs (g/yr)

Waterbody/source	*DDT total*	*PCBs total*
DomCh Estuary – TMDL	3.90	7.90
WLAs		
MS4- LA County et al	0.250	0.207
MS4 City of Long Beach	0.007	0.006
MS4 CalTrans	0.004	0.004
LAs		
Air deposition ***Bed sediments***	6.01 (2.4)	n/a 7.7
Current Load	54.0	57.5
Overall reduction	93%	86%
Consolidated Slip - TMDL	0.56	1.14
WLAs		
MS4- LA County et al	0.009	0.004
MS4 CalTrans	0.00014	0.00006
LAs		
Air deposition ***Bed sediments***	1.56 (1.00)	n/a 1.13
Current Load	49.0	83.9
Overall reduction	99%	99%
Inner Harbor - TMDL	3.56	7.22
WLAs		
MS4- LA County et al	0.051	0.059
MS4 City of Long Beach	0.014	0.016
MS4 CalTrans	0.0010	0.0011
LAs		
Air deposition ***Bed sediments***	129 (125)	n/a 7.14
Current Load	21.67	29.51
Overall reduction	84%	76%
Outer Harbor - TMDL	3.79	7.68
WLAs		
MS4- LA County et al	0.005	0.020
MS4 City of Long Beach	0.004	0.014
MS4 CalTrans	0.000010	0.00004
TIWRP = POTW ***(CTR & MGD*********)***	12.7	0.37

TMDL Element	**Regulatory Provisions**		
	LAs		
	Air deposition ***Bed sediments***	173 (182)	n/a 7.28
	Current Load	30.8	34.7
	Overall reduction	88%	78%
	<u>Fish Harbor - TMDL</u>	0.048	0.098
	WLAs		
	MS4- LA County et al	0.0003	0.0019
	MS4 CalTrans	0.0000010	0.000006
	LAs		
	Air deposition ***Bed sediments***	3.9 (3.85)	n/a 0.10
	Current Load	0.168	0.075
	Overall reduction	71%	0%
	<u>Cabrillo Marina -TMDL</u>	0.061	0.124
	WLAs		
	MS4- LA County et al	0.000028	0.000025
	MS4 CalTrans	0.00000028	0.00000024
	LAs		
	Air deposition ***Bed sediments***	3.3 (3.22)	n/a 0.12
	Current Load	1.66	1.06
	Overall reduction	96%	88%
	<u>Inner Cabrillo Beach - TMDL</u>	0.04	0.09
	WLAs		
	MS4- LA County et al	0.0001	0.0003
	LAs		
	Air deposition ***Bed sediments***	3.5 (3.5)	n/a 0.09
	Current Load	0.98	0.31
	Overall reduction	96%	72%
	<u>San Pedro Bay - TMDL</u>	30.1	61.0
	WLAs		
	MS4- LA County et al	0.049	0.44
	MS4 City of Long Beach	0.333	3.01
	MS4 CalTrans	0.002	0.019
	MS4 Orange County*	0.024	0.213
	LAs		

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Air deposition	350	n/a
Bed sediments	(320)	57.3
Current Load	205.2	110.7
Overall reduction	85%	45%
LA River Estuary - TMDL	34.1	69.2
WLAs		
MS4- LA County et al	0.100	0.324
MS4 City of Long Beach	1.067	3.441
MS4 CalTrans	0.014	0.047
LAR Estuary dischargers	[DDT SQV]	[PCBs SQV]
LAs		
Air deposition	8.9	n/a
Bed sediments	24.09	65.3
Current Load	231.6	402.2
Overall reduction	85%	83%

Note: DDT air deposition load allocation is set equal to existing load with no reductions anticipated. Negative values for bed sediments indicate that DDT bed sediment loads are expected to be reduced; the amount of reduction may be revised with additional monitoring results.
*SQVs are currently set at the more protective of ERLs or fish tissue associated sediment targets.
**Orange County MS4 Permit is issued by the Santa Ana Regional Board. The allocations included, here, for the Seal Beach nearshore area, are for TMDL calculation purposes only, and an allocation is not assigned.
***For TIWRP, the discharge volume at the time of permit modification or reissuance shall be used to calculate the mass-based effluent limitations consistent with the assumptions and requirements of these WLAs. Studies may be conducted to determine the portion of the discharged pollutants that is deposited on bed sediment. The results of any such Executive Officer approved studies shall be evaluated at the TMDL reconsideration to modify these WLAs as appropriate.

In addition, bed sediment concentration-based allocations are assigned for chlordane in Dominguez Channel Estuary, Consolidated Slip, Fish Harbor, Los Angeles River Estuary and Eastern San Pedro Bay. Bed sediment concentration-based allocations are also assigned for dieldrin in Dominguez Channel Estuary and Consolidated Slip. Bed sediment concentration allocations are also assigned for toxaphene in Consolidated Slip. The TMDLs and allocations are set at target sediment concentrations: chlordane = 0.5, dieldrin = 0.02, toxaphene = 0.10 µg/kg dry sediment.

Compliance with these bioaccumulative TMDLs may be demonstrated via any of four different means:

a. Fish tissue targets are met in species resident to the TMDL waterbodies[3].
b. Final sediment allocations, as presented above, are met.
c. Sediment numeric targets to protect fish tissue are met in bed sediments over a three-year averaging period.
d. Demonstrate that the sediment quality condition protective of fish tissue is achieved per the Statewide Enclosed Bays and Estuaries Plan, as amended to address contaminants in resident finfish and wildlife.

[3] A site-specific study to determine resident species shall be submitted to the Executive Officer for approval.

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	3. <u>Diazinon</u> Los Angeles County monitoring data in Dominguez Channel freshwaters show diazinon exceedences from 2002-2005, but none from 2006-2010. This timing is concurrent with EPA's ban on urban use of diazinon, effective Dec. 31, 2005. Based these results, no diazinon TMDLs are developed at this time.
Margin of Safety	The Dominguez Channel freshwater allocations included an explicit margin of safety (MOS) equal to 10% of the loading capacity or existing load to account for any additional uncertainty in the wet-weather TMDLs. The 10% MOS was subtracted from the loading capacity or existing load, whichever was smaller. Applying an explicit margin of safety is reasonable because a number of uncertain estimates are offset by the explicit margin of safety. While the observed dissolved-to-total metals ratios are not similar to CTR default conversion values, there appears to be very poor correlation between the fraction of particulate metals and TSS. Also, there is added uncertainty regarding stream flow rates during wet weather conditions, when the highest metal loads occur, thus an explicit margin of safety is justified. An implicit margin of safety exists in the final allocations to Dominguez Channel Estuary and Greater Harbor waters. The implicit margin of safety is based on the selection of multiple numeric targets, including targets for water, fish tissue and sediment among other conservative modeling assumptions. An additional explicit margin of safety must be considered and may be applied if any chemical-specific sediment quality target is revised or updated contingent on future sediment quality studies. That is, there may be uncertainty associated with revised sediment quality values, which may warrant including an additional explicit margin of safety.
Seasonal Variations and Critical Conditions	Wet weather events may produce extensive sediment redistribution and transport sediments to the harbors and the CTR-based water column targets are protective of this condition. This would be considered the critical condition for loading. No correlation with flow or seasonality (wet vs. dry season) was found to exist in sediment or tissue data. Given that allocations for this TMDL are expressed in terms pesticides, PCBs, PAHs, and metals concentrations in sediment, a critical condition is not identified based upon flow or seasonality. Because the adverse effects of pesticides, PCBs, PAHs, and metals are related to sediment accumulation and bioaccumulation in the food chain over long periods of time, short term variations in concentrations are less likely to cause significant impacts upon beneficial uses.
Monitoring Plan	Monitoring by assigned responsible parties is required in three waterbody areas: 1. Dominguez Channel, Torrance Lateral, and Dominguez Channel Estuary 2. Greater Los Angeles and Long Beach Harbor Waters (including Consolidated Slip) 3. Los Angeles River and San Gabriel River Monitoring shall be conducted under technically appropriate Monitoring and Reporting Plans (MRPs) and Quality Assurance Project Plans (QAPPs). The MRPs shall include a requirement that the responsible parties report compliance and non-compliance with waste load and load allocations as part of annual reports submitted to the Regional Board. The QAPPs shall include protocols for sample collection, standard analytical procedures, and laboratory certification. All samples shall be collected in accordance with SWAMP protocols. Monitoring Plans shall be submitted twenty (20) months after the effective date of the TMDL for public review and,

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	subsequently, Executive Officer approval. Monitoring shall begin six months after the monitoring plan is approved by the Executive Officer. Responsible parties assigned both WLAs and LAs may submit one document that addresses the monitoring requirements (as described below) and implementation activities for both WLAs and LAs. Responsible parties shall submit annual monitoring reports. The Regional Board Executive Officer may reduce, increase, or modify monitoring and reporting requirements, as necessary, based on the results of the TMDL monitoring program. Currently, several of the constituents of concern have numeric targets that are lower than the readily available detection limits. As analytical methods and detection limits continue to improve (i.e., development of lower detection limits) and become more environmentally relevant, responsible parties shall incorporate new method detection limits in the MRP and QAPP. 1. Dominguez Channel, Torrance Lateral, and Dominguez Channel Estuary Compliance Monitoring Program For Dominguez Channel, Dominguez Channel Estuary, and Torrance Lateral, water and total suspended solids samples shall be collected at the outlet of the storm drains discharging to the channel and the estuary. Fish tissue samples shall be collected in receiving waters of the Dominguez Channel Estuary. Sediment samples shall also be collected in the estuary. • Water Column Monitoring Water samples and total suspended solids samples shall be collected during two wet weather events and one dry weather event each year. The first large storm event of the season shall be included as one of the wet weather monitoring events. Water samples and total suspended solid samples shall be analyzed for a suite of compounds including, at a minimum, metals, including lead, zinc, and copper, DDT, PCBs, Benzo[a] anthrancene, Benzo[a]pyrene, Chrysene, Phenanthrene, and Pyrene. Sampling shall be designed to collected sufficient volumes of suspended solids to allow for analysis of the pollutants in the bulk sediment. In addition to TMDL constituents, general water chemistry (temperature, dissolved oxygen, pH, and electrical conductivity) and a flow measurement will be required at each sampling event. General chemistry measurements may be taken in the laboratory immediately following sample collection, if auto samplers are used for sample collection or if weather conditions are unsuitable for field measurements. In addition, toxicity shall be tested for in the freshwater portion of Dominguez Channel. • Sediment Monitoring A sediment monitoring program shall be developed consistent with the selected method for compliance and all samples shall be collected in accordance with SWAMP protocols. a) If compliance will be determined based on achieving sediment quality targets, sediment chemistry samples shall be collected every two years for analysis of general sediment quality constituents and the full chemical suite as specified in SQO Part 1. In addition, benthic community effects shall be assessed in the Dominguez Channel Estuary.

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	b) If compliance will be determined based on the SQO compliance method, sediment chemistry samples shall also be collected every five years (in addition to, and in between, the sediment triad sampling events as described below), beginning after the first sediment triad event, to evaluate trends in general sediment quality constituents and listed constituents relative to sediment quality targets. Chemistry data without accompanying sediment triad data shall be used to assess sediment chemistry trends and shall not be used to determine compliance. Sediment quality objective evaluation as detailed in the SQO Part 1 (sediment triad sampling) shall be performed every five years in coordination with the Biological Baseline and Bight regional monitoring programs, if possible. Sampling and analysis for the full chemical suite, two toxicity tests and four benthic indices as specified in SQO Part 1 shall be conducted and evaluated. If moderate toxicity as defined in the SQO Part 1 is observed, results shall be highlighted in annual reports and further analysis and evaluation to determine causes and remedies shall be required in accordance with the EO approved monitoring plan. Locations for sediment triad assessment and the methodology for combining results from sampling locations to determine sediment conditions shall be specified in the MRP to be approved by the Executive Officer. The sampling design shall be in compliance with the SQO Part 1 Sediment Monitoring section (VII.E.). • Fish Tissue Monitoring Fish tissue samples shall be collected every two years from the Dominguez Channel Estuary and analyzed for chlordane, dieldrin, toxaphene, DDT, and PCBs. The target species in the Dominguez Channel Estuary shall be selected based on residency, local abundance and fish size at the time of field collection. Tissues analyzed shall be based on the most common preparation for the selected fish species. The Dominguez Channel responsible parties are each individually responsible for conducting water, sediment, and fish tissue monitoring. However, they are encouraged to collaborate or coordinate their efforts to avoid duplication and reduce associated costs. Dischargers interested in coordinated monitoring shall submit a coordinated MRP that identifies monitoring to be implemented by the responsible parties. Under the coordinated monitoring option, the compliance point for the stormwater WLAs shall be storm drain outfalls or a point(s) in the receiving water that suitably represents the combined discharge of cooperating parties. The details of the monitoring program including sampling locations and all methods shall be specified in the MRP to be approved by the Executive Officer. 2. Greater Los Angeles and Long Beach Harbor Waters Compliance Monitoring Program At a minimum, compliance monitoring shall be conducted at the locations and for the constituents listed in the table below for water column, total suspended solids, and sediment. The exact locations of monitoring sites shall be specified in the MRP to be approved by the Executive Officer. During aspects of the remedial action(s) for the Montrose Superfund Site that may mobilize sediments and associated pollutants from the on- or near-property soils or "Neighborhood Areas", it is recommended that US EPA, as the regulatory oversight agency, require that Potentially Responsible Parties (PRP) implement monitoring to evaluate pollutant loads and concentrations leaving the site and surrounding area, as well as pollutant

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concentrations in the bed sediments of Dominguez Channel Estuary and Consolidated Slip and coordinate such monitoring with other TMDL compliance monitoring.

- Water Column Monitoring

Water samples and total suspended solids samples shall be collected during two wet weather events and one dry weather event each year. TSS shall be collected at several depths during wet weather events. The first large storm event of the season shall be included as one of the wet weather monitoring events. General water chemistry (temperature, dissolved oxygen, pH, and salinity) and a flow measurement shall be required at each sampling event.

- Sediment Monitoring

Sediment chemistry samples shall be collected every five years (in addition to, and in between, the sediment triad sampling events as described below), beginning after the first sediment triad event, to evaluate trends in general sediment quality constituents and listed constituents relative to sediment quality targets. Chemistry data without accompanying sediment triad data shall be used to assess sediment chemistry trends and shall not be used to determine compliance.

Sediment chemistry monitoring requirements

Water Body Name	Station Id	Station Location	Sample Media	
			WATER/TSS	SEDIMENT
Consolidated Slip	01	Center of Consolidated Slip	Metals, PCBs, DDT	Metals, Chlordane, DDT PCBs, PAHs
Los Angeles Inner Harbor	02	East Turning Basin	Metals, PCBs, DDT	Metals, Toxicity, Benthic Community Effect
	03	Center of the POLA West Basin	Metals, PCBs, DDT	
	04	Main Turning Basin north of Vincent Thomas Bridge	Metals, PCBs, DDT	
	05	Between Pier 300 and Pier 400	Metals, PCBs, DDT	Metals, Toxicity, Benthic Community Effect
	06	Main Channel south of Port O'Call	Metals, PCBs, DDT	Metals, Toxicity, Benthic Community Effect
Fish Harbor	07	Center of inner portion of Fish Harbor	Metals, PCBs, DDT	Metals, Toxicity, PCBs, DDT, Chlordane, PAHs
Los Angeles Outer Harbor	08	Los Angeles Outer Harbor between Pier 400 and middle breakwater	Metals, PCBs, DDT	Toxicity
	09	Los Angeles Outer Harbor between the southern end of the reservation point and the San Pedro breakwater	Metals, PCBs, DDT	Toxicity
Cabrillo Marina	10	Center of west Channel	Metals, PCBs, DDT	
Inner Cabrillo	11	Center of Inner	Metals, PCBs,	Metals

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Beach		Cabrillo Beach	DDT	
Long Beach Inner Harbor	12	Cerritos Channel between the Heim Bridge and the Turning Basin	Metals, PCBs, DDT	Metals, Toxicity, Benthic Community Effect
	13	Back Channel between Turning Basin and West Basin	Metals, PCBs, DDT	Metals, Toxicity, Benthic Community Effect
	14	Center of West Basin	Metals, PCBs, DDT	Metals, Toxicity, Benthic Community Effect
	15	Center of Southeast Basin	Metals, PCBs, DDT	Metals, Toxicity, Benthic Community Effect
Long Beach Outer Harbor	16	Center of Long Beach Outer Harbor	Metals, PCBs, DDT	Toxicity
	17	Between the southern end of Pier J and the Queens Gate	Metals, PCBs, DDT	Toxicity
San Pedro Bay	18	Northwest of San Pedro Bay near Los Angeles River Estuary	Metals, PCBs, DDT	Metals, Chlordane, PAHs, Toxicity
	19	East of San Pedro Bay	Metals, PCBs, DDT	Metals, Chlordane, PAHs, Toxicity
	20	South of San Pedro Bay inside breakwater	Metals, PCBs, DDT	Metals, Chlordane, PAHs, Toxicity
Los Angeles River Estuary	21	Los Angeles River Estuary Queensway Bay	Metals, PCBs, DDT	Metals, Chlordane, DDT, PCBs
	22	Los Angeles River Estuary	Metals, PCBs, DDT	Metals, Chlordane, DDT, PCBs

Sediment quality objective evaluation as detailed in the SQO Part 1 (sediment triad sampling) shall be performed every five years in coordination with the Biological Baseline and Bight regional monitoring programs, if possible. Sampling and analysis for the full chemical suite, two toxicity tests and four benthic indices as specified in SQO Part 1 shall be conducted and evaluated. If moderate toxicity as defined in the SQO Part 1 is observed, results shall be highlighted in annual reports and further analysis and evaluation to determine causes and remedies shall be required in accordance with the EO approved monitoring plan. Locations for sediment triad assessment and the methodology for combining results from sampling locations to determine sediment conditions shall be specified in the MRP to be approved by the Executive Officer. The sampling design shall be in compliance with the SQO Part 1 Sediment Monitoring section (VII.E.).

- Fish Tissue Monitoring
  Fish tissue samples shall be collected every two years in San Pedro Bay, Los Angeles Harbor, and Long Beach Harbor, and analyzed for chlordane, dieldrin, toxaphene, DDT, and PCBs. At a minimum, three species shall be collected, including white croaker, a sport

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	fish, and a prey fish. The Greater Los Angeles and Long Beach Harbors[3] responsible parties are each individually responsible for conducting water, sediment, and fish tissue monitoring. However, they are encouraged to collaborate or coordinate their efforts to avoid duplication and reduce associated costs. Dischargers interested in coordinated compliance monitoring shall submit a coordinated MRP that identifies monitoring to be conducted by the responsible parties. Under the coordinated compliance monitoring option, the compliance point for the stormwater WLAs shall be storm drain outfalls or a point(s) in the receiving water that suitably represents the combined discharge of cooperating parties. The Consolidated Slip sub-group responsible parties are responsible for conducting water, sediment, and fish tissue monitoring in Consolidated Slip. The details of the monitoring program including sampling locations and all methods shall be specified in the MRP to be approved by the Executive Officer. 3. Los Angeles River and San Gabriel River Compliance Monitoring Program Los Angeles River Watershed and San Gabriel River Watershed responsible parties identified in effective metals TMDLs for Los Angeles River and San Gabriel River are responsible for conducting water and sediment monitoring above the Los Angeles River Estuary and at the mouth of the San Gabriel River, respectively, to determine the Rivers' contribution to the impairments in the Greater Harbor waters. • Water Column Monitoring Water samples and total suspended solids samples shall be collected at, at least one site during two wet weather events and one dry weather event each year. The first large storm event of the season shall be included as one of the wet weather monitoring events. Water samples and total suspended solid samples shall be analyzed for metals, DDT, PCBs, and PAHs. Sampling shall be designed to collect sufficient volumes of suspended solids to allow for analysis of the listed pollutants in the bulk sediment. General water chemistry (temperature, dissolved oxygen, pH, and electrical conductivity) and a flow measurement shall be required at each sampling event. General chemistry measurements may be taken in the laboratory immediately following sample collection if auto samplers are used for sample collection or if weather conditions are unsuitable for field measurements. • Sediment Monitoring For sediment chemistry, sediment samples shall be collected at, at least one site every two years for analysis of general sediment quality constituents and the full chemical suite as specified in SQO Part 1. All samples shall be collected in accordance with SWAMP protocols. The details of the monitoring program including sampling locations and all methods shall be specified in the MRP to be approved by the Executive Officer.

Implementation Plan

The regulatory mechanisms to implement the TMDL include, but are not limited to, general NPDES permits, individual NPDES permits, MS4 Permits covering jurisdictions and flood control districts within these waters, the Statewide Industrial Storm Water General Permit, the Statewide Construction Activity Storm Water General Permit, the Statewide Stormwater Permit for Caltrans Activities, and the authority contained in Sections 13263, 13267 and 13383 of the Cal. Water Code. For each discharger assigned a WLA, the appropriate Regional Board Order shall be reopened or amended when the order is reissued, in accordance with applicable laws, to incorporate the applicable WLA(s) as a permit requirement consistent with federal regulation and related guidance (40 CFR 144.22(d)(1)(vii)(B); US EPA Memorandum "Revisions to the November 22, 2002 Memorandum 'Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs'" (November 12, 2010)). LAs will be implemented in a manner consistent with federal and state laws, regulations and policies, including the Nonpoint Source Implementation and Enforcement Policy.

Implementation by assigned responsible parties is required in three waterbody areas:
1. Dominguez Channel, Torrance Lateral, and Dominguez Channel Estuary
2. Greater Los Angeles and Long Beach Harbor waters (including Consolidated Slip)
3. Los Angeles River and San Gabriel River

Actions to achieve WLA and LA may be implemented in phases with information from each phase being used to inform the implementation of the next phase. These sediment targets are not intended to be used as 'clean-up standards' for navigational, capital or maintenance dredging or capping activities; rather they are long-term sediment concentrations that should be attained after reduction of external loads, targeted actions addressing internal reservoirs of contaminants, and environmental decay of contaminants in sediment. The implementation may be adjusted, as necessary, based on information gained during each phase. Table 7-40.2 contains the schedule for responsible parties to develop and implement TMDL implementation plans and sediment management plans to comply with the TMDL.

1. ***Dominguez Channel, Torrance Lateral, and Dominguez Channel Estuary***

Responsible parties can implement a variety of implementation strategies to meet the required WLAs and LAs, such as non-structural and structural BMPs, diversion and treatment to reduce sediment transport from the watershed to Dominguez Channel and Greater Harbor waters, and sediment removal activities.

Nonpoint source elements include legacy sediments and air deposition across Dominguez Channel and Harbor waters. The responsible parties identified in the Allocation section and in part 6. *Application of Allocations to Responsible Parties* of this section are assigned sediment load allocations and responsibility for remediation of the contaminated sediments to attain the load allocations.

- Phase I

  The purpose of the Phase I implementation is to reduce the amount of sediment transport from point sources that directly or indirectly discharge to Dominguez Channel and the Harbor waters. Phase I should include watershed-wide implementation actions. Important components of Phase I should be to secure the relationships and agreements between cooperating parties and to develop a detailed scope of work with priorities.

Potential watershed-wide non-structural BMPs include more frequent and appropriately timed storm drain catch basin cleaning, improved street cleaning by upgrading to vacuum type sweepers, and educating residents and industries about good housekeeping practices. Structural BMPs may include the placement of stormwater treatment devices designed to reduce sediment loading, such as infiltration trenches, vegetated swales, and/or filter strips at critical points in the watershed. Structural BMPs may also include diversion and treatment facilities to divert runoff directly, or provide capture and storage of runoff and then diversion to a location for treatment. Treatment options to reduce sediment could include sand or media filters.

The Los Angeles County Flood Control District (District) owns and operates Dominguez Channel; therefore, the District and the cities that discharge to Dominguez Channel shall each be responsible for conducting implementation actions to address contaminated sediments in Dominguez Channel. Responsible parties in Dominguez Channel shall develop a Sediment Management Plan to address contaminated sediment in Dominguez Channel and Dominguez Channel Estuary.

Sediment conditions shall be evaluated through the Sediment Quality Objective (SQO) process detailed in the SQO Part 1. If chemicals within sediments are contributing to an impaired benthic community or toxicity, then causative agent(s) shall be determined using SQO recommended procedures, SQO Part 1 (VII.F.). Impacted sediments shall be included in the list of sites to be managed.

- Phase II

Phase II should include the implementation of additional BMPs and site remedial actions, as determined to be effective based on the success of upstream source control, evaluation of TMDL monitoring data collected during Phase I, and targeted source reduction activities as identified in Phase I. Regional responsible parties should develop, prioritize, and implement Phase II elements based on data from the TMDL monitoring program and other available information from special studies. Possible actions include implementation of additional structural and non-structural BMPs throughout the watershed by municipalities, LA County, Caltrans, and others. Phase II should include the implementation of site-specific cleanup actions for areas identified as high priority in the Dominguez Channel Estuary and in accordance with the Sediment Management Plan.

  - As management actions are planned for a contaminated site, site-specific cleanup criteria should be determined following protocols that are consistent with state and national guidance. The site improvements should be confirmed through a sediment monitoring program.
  - There are two Superfund sites located within Dominguez Channel Watershed: the Montrose Superfund Site and the Del Amo Superfund Site. The US EPA has not yet reached a final remedial decision with respect to certain of the Montrose Superfund Site Operable Units (OUs) that remain contaminated with DDT, including the on- and near-property soils (OU1), the current storm water pathway (OU2), and the "Neighborhood Areas" (OU4 and OU6). The TMDL, its waste load and load allocations, and other regulatory provisions of this TMDL may be applicable or relevant and appropriate requirements (ARARs) as set forth in Section 121(d) of the Comprehensive Environmental Response, Compensation, and Liability Act (42 U.S.C. §§ 9621(d)) for those OUs. Whether provisions within the TMDL are ARARs will be determined in accordance with CERCLA

when US EPA develops Records of Decision for the Superfund sites. The TMDL for DDT should be taken into account in the course of the remedial decision-making process. The City of Los Angeles and/or Los Angeles County, should they decide to take action that impacts one of the OUs, shall consult with US EPA's Superfund Division in advance of such action. Detection of DDT compounds in water or sediment samples collected within Torrance Lateral shall trigger additional monitoring, by parties to be determined by the Executive Officer, in coordination with EPA, to evaluate potential contribution from contaminated soils related to upstream Montrose operable units discharging via the Kenwood storm drain. Upon reconsideration of the TMDL, all monitoring results for DDT compounds collected by responsible parties or other entities shall be considered as part of source analysis and to determine potential future allocation(s) that may be necessary to minimize impacts to downstream waters and restore beneficial uses in TMDL waterbodies.

- Phase III

Phase III should include implementation of secondary and additional remediation actions as necessary to be in compliance with final allocations by the end of the implementation period. TMDLs to allocate additional contaminant loads between dischargers in the Dominguez Channel, Torrance Lateral and Dominguez Channel Estuary subwatersheds may also be developed, if necessary.

2. ***Greater Los Angeles and Long Beach Harbor Waters (including Consolidated Slip)***

Responsible parties can implement a variety of implementation strategies to meet the required WLAs, such as non-structural and structural BMPs, and/or diversion and treatment to reduce sediment transport from the nearshore watershed to the Greater Harbor waters.

- Phase I

The purpose of Phase I implementation is to reduce the amount of sediment transport from point sources that directly or indirectly discharge to the Harbor waters. Phase I should include actions to be implemented throughout the nearshore watershed and specific implementation actions at the Ports. Important components of Phase I should be to secure the relationships and agreements between cooperating parties and to develop a detailed scope of work with priorities.

Potential watershed-wide non-structural BMPs include more frequent and appropriately timed storm drain catch basin cleaning, improved street cleaning by upgrading to vacuum type sweepers, and educating residents and industries about good housekeeping practices. Structural BMPs may include the placement of stormwater treatment devices designed to reduce sediment loading, such as infiltration trenches, vegetated swales, and/or filter strips at critical points in the watershed. Structural BMPs may also include diversion and treatment facilities to divert runoff directly, or provide capture and storage of runoff and then diversion to a location for treatment. Treatment options to reduce sediment could include sand or media filters.

Implementation actions at the Ports should be developed to address different sources that contribute loading to the Harbors such as Port-wide activities and associated control measures for water and sediment, control measures to reduce the discharges from various land uses in the Harbors, nearshore discharges, and on-water discharges. The implementation actions described in the *Water Resources Action Plan* (WRAP) adopted by the Port of Los Angeles and the Port of Long Beach represent a range of activities that could be conducted to control discharges of polluted stormwater and contaminated sediments to the Harbors.

To meet necessary reductions in sediment bed loads, a Sediment Management Plan shall be developed by the dischargers assigned a sediment bed load LA, the Cities of Los Angeles and Long Beach and the State Lands Commission. Phase I implementation elements for the improvement of the Harbors' sediment quality should be conducted through the continuation of source reduction, source control, and sediment management. Below are proposed implementations actions that may be implemented in Phase I to improve sediment quality at the ports:

- *Removal of Contaminated Sediment within Areas of Known Concern*. Planned removal programs are in place for IR Site 7 (former Navy facility in the Port of Long Beach) and Berth 240 (former Southwest Marine facility in the Port of Los Angeles). Contaminated sediment will be removed by Port of Long Beach and Port of Los Angeles.

- *Sediment Management Plan, Prioritization Assessment for Contaminated Sediment Management.* Sediment will be evaluated through the Sediment Quality Objective (SQO) process detailed in the Enclosed Bays and Estuaries Plan (i.e., SQO Part 1 as amended). If chemicals within sediments are contributing to an impaired benthic community or toxicity, or fish tissue, then causative agent(s) will be determined using SQO recommended procedures, including SQO Part I (VII. F.). Impacted sediments will be included in the list of sites to be managed. The sites to be managed by the responsible parties will be prioritized for management and coupled with other planned projects when feasible. Prioritized sites shall include known hot spots, including but not limited to Consolidated Slip and Fish Harbor. For these prioritized sites, the sediment management plan shall include concrete actions and milestones, including numeric estimates of load reductions or removal, to remediate these priority areas and shall demonstrate that actions to address prioritized hot spots will be initiated and completed as early as possible during the 20-year TMDL implementation period. This process will prioritize management efforts on sites that have the greatest impact to the overall health of the benthic community and fish tissue, and allow sites with lower risks to be addressed in later phases when opportunities can be coupled to capital projects. As management actions are planned for a contaminated site, site-specific cleanup criteria will be determined following established protocols that are consistent with state and national policy and guidance. The site will then be managed and the improvements confirmed through a sediment monitoring program.

- *Superfund Sites.* Two Superfund sites are located in Dominguez Channel Watershed: the Montrose Superfund Site (DDT) and the Del Amo Superfund Site (benzene). Montrose Superfund Site includes multiple operable units (OUs), which are identified as investigation areas potentially containing site-related contamination. These Superfund Sites are located in a community known as Harbor Gateway, which is situated mostly in the City of Los Angeles and partially in unincorporated land in Los Angeles County. Harbor Gateway lies within the Kenwood Drain subwatershed, which discharges stormwater into Torrance Lateral which flows downstream into saline waters of Dominguez Channel Estuary and Consolidated Slip. The Torrance Lateral, Dominguez Channel Estuary and Consolidated Slip (OU2) contain sediments contaminated with multiple pollutants including DDT (potentially from various sources). The US Environmental Protection Agency (US EPA) has been working with other government agencies and local agencies including the City of Los Angeles and Los Angeles County to ensure the protection of both the environment and public health in the areas surrounding these Superfund sites.

In August 1999, USEPA and the State of California, which includes the Regional Board, entered into a consent decree concerning the Montrose Superfund site in a case entitled *United States of America and State of California versus Montrose Chemical Corporation of California, et al*., United States District Court Central District of California, Case No. CV 90-3122-AAH (JRx).

The US EPA has not yet reached a final remedial decision with respect to certain of the Montrose Superfund Site Operable Units (OUs) that remain contaminated with DDT, including the on- and near-property soils (OU1), the current storm water pathway (OU2), and the "Neighborhood Areas" (OU4 and OU6). The TMDL, its waste load and load allocations, and other regulatory provisions of this TMDL may be applicable or relevant and appropriate requirements (ARARs) as set forth in Section 121(d) of the Comprehensive Environmental Response, Compensation, and Liability Act (42 U.S.C. §§ 9621(d)) for those OUs. Whether provisions within the TMDL are ARARs will be determined in accordance with CERCLA when USEPA develops Records of Decision for the Superfund sites. The TMDL for DDT should be taken into account in the course of the remedial decision-making process. US EPA Superfund does not need to make a remedial decision prior to individual or collective action (by City of LA and/or County of LA) to clean up sediments within the OU2 pathway. The City of Los Angeles and/or Los Angeles County, should they decide to take action that impacts one of the OUs, shall consult with US EPA's Superfund Division in advance of such action. The goal of consultation is to ensure the proposed sediment cleanup will not aggravate the situation or further interfere with the OU2 site. Detection of DDT compounds in water or sediment samples collected within Torrance Lateral shall trigger additional monitoring, by parties to be determined by the Executive Officer, in coordination with EPA, to evaluate potential contribution from contaminated soils related to upstream Montrose operable units discharging via the Kenwood storm drain. Upon reconsideration of the TMDL, all monitoring results for DDT compounds collected by responsible parties or other entities shall be considered as part of source analysis and to determine potential future allocation(s) that may be necessary to minimize impacts to downstream waters and restore beneficial uses in TMDL waterbodies.

- Phase II

Phase II should include the implementation of additional BMPs and site remedial actions in the nearshore watershed and in the Harbors, as determined to be effective based on the success of upstream source control, TMDL monitoring data evaluations, WRAP activities implemented during Phase I, and targeted source reduction activities as identified in Phase I. Responsible parties should develop, prioritize, and implement Phase II elements based on data from the TMDL monitoring program and other available information from special studies. Possible actions include additional structural and non-structural BMPs throughout the watershed.

Phase II should include the implementation of site-specific cleanup actions for areas identified as high priority in the Harbor waters and per the Sediment Management Plan.

- Phase III

The purpose of Phase III is to implement secondary and additional remediation actions as necessary to be in compliance with final waste load and load allocations by the end of the TMDL implementation period.

3. Los Angeles River and San Gabriel River

Responsible parties in these watersheds are implementing other TMDLs, which will directly or indirectly support the goals of this TMDL.

- Phase I

Responsible parties for each watershed shall submit a Report of Implementation to describe how current activities support the downstream TMDL.

- Phases II and III

Implementation actions may be developed and required in Phases II and III as necessary to meet the targets in the Greater Harbor waters. TMDLs to allocate contaminant loads between dischargers in the Los Angeles and San Gabriel Rivers watersheds may also be developed, if necessary.

4. Special Studies and Reconsideration of TMDL Targets, Allocations, and Schedule

This TMDL recognizes that as work to understand these waters and the chemical, physical and biological processes, continues, the targets, allocations, and the flow threshold for wet-weather conditions and the implementation actions to reach those targets and allocations may need to be adjusted. Furthermore, if impairments are identified during flow conditions less than the 90th percentile flow in Dominguez Channel and/or Torrance Lateral, additional allocations for those flow conditions will be developed and applied at the TMDL reconsideration. In addition, it may be necessary to make adjustments to the TMDL to be responsive to new State policies including, but not limited to, SQO Part II; toxicity policy; possible changes to air quality criteria and other regulations affecting air quality.

Optional special studies, which could result in changes to these TMDLs, include but are not limited to: studies to further refine the site specific link between sediment pollutant concentrations, depth of bed sediment contamination and fish tissue concentrations; foraging ranges of targeted fish; additional data to refine watershed and hydrodynamic models, including that collected pursuant to this TMDL; additional data on contaminant contributions of the Los Angeles River or San Gabriel River to Greater Harbor waters; stressor identifications; and additional diazinon data. Completion of studies to further refine the site specific link between sediment pollutant concentrations and fish tissue pollutant concentrations and evaluate the range and habitat of specific fish populations will be used to evaluate changes in TMDL targets, WLAs and LAs, and to guide future implementation actions. In addition, further characterization of direct air deposition loadings for heavy metals and legacy pesticides is an optional special study. Allocations of certain pollutants in certain waterbodies are confounded by the existing estimates of pollutant loading via direct air deposition onto the waterbodies. Additional monitoring of these pollutants at air sampling sites more closely resembling the respective waterbodies will help characterize these loadings. Limited data exist for dry deposition so this study could be extended over longer timeframes. Measurements of wet deposition for each pollutant may also be appropriate to estimate air deposition more completely. Study results could provide data to reconsider pollutant-specific allocations in this TMDL.

Detection of DDT compounds in water or sediment samples collected within Torrance Lateral shall trigger additional monitoring, by parties to be determined by the Executive Officer, in coordination with EPA, to evaluate potential contribution from contaminated soils related to upstream Montrose operable units discharging via the Kenwood storm drain. Upon reconsideration of the TMDL, all monitoring results for DDT compounds collected by responsible parties or other entities shall be considered as part of source analysis and to determine potential future allocation(s) that may be necessary to minimize impacts to downstream waters and restore beneficial uses in TMDL waterbodies.

As allocation-specific data are collected, interim targets for the end of Phase II may be identified.

The TMDL will be reconsidered by the Regional Board at the end of Phase I to consider completed special studies or policy changes.

5. Compliance with Allocations and Attainment of Numeric Targets

Compliance with the TMDL shall be determined through water, sediment, and fish tissue monitoring and comparison with the TMDL waste load and load allocations and numeric targets. Compliance with the sediment TMDL for metals and PAH compounds shall be based on achieving the loads and waste load allocations or, alternatively, demonstrating attainment of the SQO Part 1 through the sediment triad/multiple lines of evidence approach outlined therein. Compliance with the TMDLs for bioaccumulative compounds shall be based on achieving the assigned loads and waste load allocations or, alternatively, by meeting fish tissue targets. If at any point during the implementation plan, monitoring data or special studies indicate that load and waste load allocations will be attained, but fish tissue targets may not be achieved, the Regional Board shall reconsider the TMDL to modify the waste load and load allocations to ensure that the fish tissue targets are attained.

The compliance point for the stormwater WLAs shall be at the storm drain outfall of the permittee's drainage area. Alternatively, if stormwater dischargers select a coordinated compliance monitoring option, the compliance point for the stormwater WLA may be at storm drain outfalls or at a point in the receiving water, which suitably represents the combined discharge of cooperating parties discharging to Dominguez Channel and Greater Los Angeles and Long Beach Harbor waters. Depending on potential BMPs implemented, alternative stormwater compliance points may be proposed by responsible parties subject to approval by the Regional Board Executive Officer. The compliance point(s) for responsible parties receiving load allocations shall be in the receiving waters or the bed sediments of the Dominguez Channel and the Greater Los Angeles and Long Beach waters.

6. Application of Allocations to Responsible Parties

Responsible parties for monitoring and to attain LAs and WLAs for this TMDL include but are not limited to:

1. Dominguez Channel Responsible Parties
   - Dominguez Channel, Torrance Lateral, and Dominguez Channel Estuary MS4 Permittees
     - Los Angeles County
     - Los Angeles County Flood Control District
     - Caltrans
     - City of Carson
     - City of Compton
     - City of El Segundo
     - City of Gardena
     - City of Hawthorne
     - City of Inglewood
     - City of Lawndale
     - City of Long Beach
     - City of Los Angeles
     - City of Manhattan Beach
     - City of Redondo Beach
     - City of Torrance
   - Individual and General Stormwater Permit Enrollees
   - Other Non-stormwater Permittees
   - Dominguez Channel Estuary Subgroup for bed sediment and fish:
     - Los Angeles County
     - Los Angeles County Flood Control District
     - Caltrans
     - City of Carson
     - City of Compton
     - City of Gardena
     - City of Los Angeles
     - City of Long Beach
     - City of Torrance

2. Greater Los Angeles and Long Beach Harbor Waters Responsible Parties
   - Greater Los Angeles and Long Beach Harbor Waters MS4 Permittees
     - Los Angeles County
     - Los Angeles County Flood Control District
     - Caltrans
     - Bellflower
     - City of Lakewood
     - City of Long Beach
     - City of Los Angeles
     - City of Paramount
     - City of Signal Hill
     - City of Rolling Hills
     - City of Rolling Hills Estates
     - Rancho Palos Verdes
   - City of Los Angeles (including the Port of Los Angeles)
   - City of Long Beach (including the Port of Long Beach)
   - State Lands Commission

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Individual and General Stormwater Permit Enrollees
Other Non-stormwater Permittees, including City of Los Angeles (TIWRP)
<u>Los Angeles River Estuary Subgroup for bed sediment and fish:</u>

Los Angeles County
Los Angeles County Flood Control District
City of Long Beach
City of Los Angeles
City of Signal Hill
Caltrans

Consolidated Slip Responsible Parties subgroup[4]

Consolidated Slip MS4 Permittees

Los Angeles County
Los Angeles County Flood Control District
City of Los Angeles

3. Los Angeles River and San Gabriel River Watershed TMDLs Responsible Parties

Los Angeles River and San Gabriel River metals TMDLs responsible parties (For list of responsible parties, see Chapter 7-13 herein and US EPA, “Total Maximum Daily Loads for Metals and Selenium: San Gabriel River and Impaired Tributaries”, March 26, 2007.)

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[4] US EPA is the regulatory oversight agency pursuant to CERCLA with respect to the two Superfund sites within the Consolidated Slip subarea, but is not identified as a Responsible Party under the TMDL. As the regulatory oversight agency, US EPA is responsible for choosing an appropriate remedy for these sites. Furthermore, under CERCLA, US EPA is responsible for assuring that the CERCLA PRPs clean up the site in compliance with CERCLA and applicable or relevant and appropriate requirements (ARARs) (CERCLA section 121(d)).

Table 7-40.2 Dominguez Channel and Greater Los Angeles and Long Beach Harbor Waters Toxic Pollutants TMDL: Implementation Schedule

Task Number	Task	Responsible Party	Deadline
1	Interim allocations are achieved.	All Responsible Parties	Effective date of the TMDL
2	Submit a Monitoring Plan to the Los Angeles Regional Board for Executive Officer approval.	Dominguez Channel Responsible parties; Greater Harbors Responsible Parties; Consolidated Slip Responsible Parties subgroup; Los Angeles and San Gabriel River Responsible Parties	20 months after effective date of the TMDL
3	Implement Monitoring Plan	Dominguez Channel Responsible parties; Greater Harbors Responsible Parties; Consolidated Slip Responsible Parties subgroup; Los Angeles and San Gabriel River Responsible Parties	6 months after monitoring plan approved by Executive Officer.
4	Submit annual monitoring reports to the Los Angeles Regional Board.	All Responsible parties	15 months after monitoring starts and annually thereafter
5	Submit an Implementation Plan and Contaminated Sediment Management Plan (CSMP). The Implementation Plan and CSMP shall be circulated for public review for 30 days. The CSMP shall include concrete milestones with numeric estimates of load reductions or removal, including milestones for remediating hot spots, including but not limited to Dominguez Channel Estuary, Consolidated Slip and Fish Harbor, for Executive Officer approval. The Executive Officer shall consider the Consent Decree for the Montrose Superfund site in determining whether to approve the CSMPs.	Dominguez Channel Responsible parties; Greater Harbors Responsible Parties; Consolidated Slip Responsible Parties subgroup	2 years after effective date of the TMDL
6	Submit Report of Implementation to the Los Angeles Regional Board.	Los Angeles and San Gabriel River Responsible Parties	2 years after effective date of the TMDL
7	Submit annual implementation reports to the Los Angeles Regional Board. Report on implementation progress and demonstrate progress toward meeting the assigned LAs and WLAs.	All Responsible parties	3 years after effective date of the TMDL and annually thereafter
8	Complete Phase I of TMDL Implementation Plan and Sediment Management Plan.	Dominguez Channel Responsible parties; Greater Harbors Responsible Parties;	5 years after effective date of the TMDL

Task Number	Task	Responsible Party	Deadline
		Consolidated Slip Responsible Parties subgroup	
9	Submit updated Implementation Plan and Contaminated Sediment Management Plan.	Dominguez Channel Responsible parties; Greater Harbors Responsible Parties; Consolidated Slip Responsible Parties subgroup	5 years after effective date of the TMDL
10	Regional Board will reconsider targets, WLAs, and LAs based on new policies, data or special studies. Regional Board will consider requirements for additional implementation or TMDLs for Los Angeles and San Gabriel Rivers and interim targets and allocations for the end of Phase II.	Regional Board	6 years after the effective date of the TMDL
11	Report on status of implementation and scope and schedule of remaining Phase II implementation actions to Regional Board.	All Responsible parties	10 years after the effective date of the TMDL
12	Complete Phase II of TMDL Implementation Plan and Sediment Management Plan.	Dominguez Channel Responsible parties; Greater Harbors Responsible Parties; Consolidated Slip Responsible Parties subgroup	15 years after effective date of the TMDL
13	Complete Phase III of TMDL Implementation Plan and Sediment Management Plan.	Dominguez Channel Responsible parties; Greater Harbors Responsible Parties; Consolidated Slip Responsible Parties subgroup	20 years after effective date of the TMDL
14	Demonstrate attainment of LAs and WLAs using the means identified under Waste Load and Load Allocations in Table 7-40.1	All Responsible parties	20 years after effective date of the TMDL