ECONOMIC CONSIDERATIONS OF PROPOSED AMENDMENTS TO THE SEDIMENT QUALITY PLAN FOR ENCLOSED BAYS AND ESTUARIES IN CALIFORNIA

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State Water Resources Control Board
Division of Water Quality
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List of Exhibits

Acronyms and Abbreviations

BAT	Best available technology economically achievable
BCT	Best conventional pollutant control technology
BMPs	Best management practices
BPTCP	Bay Protection and Toxic Cleanup Program
CACs	County Agricultural Commissioners
CalEPA	California Environmental Protection Agency's
Caltrans	California Department of Transportation
CCA	California Coastal Act
CCC	California Coastal Commission
CCLEAN	Central Coast Long-term Environmental Assessment Network
CDF	California Department of Forestry
cfs	Cubic feet per second
CTR	California Toxics Rule
CSTF	Contaminated Sediments Task Force
CWA	Clean Water Act
CWC	California Water Code
CZARA	Coastal Zone Act Reauthorization Amendments of 1990
DOC	Department of Conservation
DPR	Department of Pesticide Regulation
DTSC	Cal/EPA Department of Toxic Substances Control
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
FPR	Forest Practice Rules
IPM	Integrated pest management
LCP	Local costal plan
LEAs	Local Enforcement Agencies
MEP	Maximum Extent Practicable
MLOE	Multiple lines of evidence
MBNEP	Morro Bay National Estuary Program
MMs	Management measures
MS4s	Municipal separate storm sewer systems
NPDES	National Pollutant Discharge and Elimination System
NPS	Nonpoint Source
OEHHA	Office of Environmental Health Hazard Assessment
OPA	Oil Pollution Act
PAHs	Polynuclear aromatic hydrocarbons
PBDEs	Polybrominated diphenyl ethers
PCBs	Polychlorinated biphenyls
Regional Water Board	Regional Water Quality Control Board
RHMP	Regional Harbors Monitoring Plan
RMP	Regional Monitoring Plan
RWB	Regional Water Board
SCCWRP	Southern California Coastal Water Research Program
SFEI	San Francisco Estuary Institute
SIYB	Shelter Island Yacht Basin
SMARA	Surface Mining and Reclamation Act
SSO	Site Specific Objective
SWRCB	State Water Resources Control Board (State Water Board)

SWAMP	Surface Water Ambient Monitoring Program
SWMP	Storm Water Management Plans
SWPPP	Storm Water Pollution Prevention Plan
SQOs	Sediment quality objectives
THPs	Timber harvest plans
TIE	Toxicity identification evaluation
TMDL	Total Maximum Daily Load
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
WDRs	Waste discharge requirements
WQBEL	Water Quality-Based Effluent Limits
WWQI	Westside Water Quality Improvement

Executive Summary

The State Water Resource Control Board (State Water Board) staff is proposing amendments to the state's Water Quality Control Plan for Enclosed Bays and Estuaries: Part 1 Sediment Quality (referred to in this report as either "Part 1" or "the Plan"). The amendments include additional sediment quality objectives (SQOs) and implementation procedures that apply to enclosed bays and estuaries in California. This report provides analysis of economic factors related to the Plan amendments.

Background

In 2008, the State Water Board adopted SQOs and an implementation policy for bays and estuaries in the state (Part 1). 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 includes narrative SQOs for the protection of aquatic life and human health; identification of the beneficial uses that these objectives are intended to protect; and a program of implementation that contains specific indicators, tools, and implementation provisions to determine if the sediment quality at a station or multiple stations meets the narrative objectives, description of appropriate monitoring programs, and 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. The State Water Board is proposing amendments to the Plan to incorporate additional SQOs for the protection of wildlife and finfish and implementation policy.

In establishing water quality objectives, the State Water Board considers economic factors, among others. Specifically, these economic factors include whether the objectives and alternatives under consideration are currently being attained, the methods available to achieve compliance, and the costs of those methods. The State Water Board is considering these same factors in developing the SQOs. The available compliance methods and costs depend on the sources of the pollutants bioaccumulating in sediments in bays and estuaries, which could include municipal and industrial wastewater and storm water, agriculture, boats, and legacy sources.

Baseline conditions include current sediment quality objectives (e.g., benthic community and human health SQOs and narrative Basin Plan criteria), water quality objectives and policies regulating activities and pollutant discharges that affect sediment quality (e.g., CTR, Basin Plans, waste discharge requirements, and other policies), ongoing cleanup and remediation activities, and planned or anticipated cleanup and remediation actions that have not yet been completed [e.g., total maximum daily load development (TMDL) and implementation schedules]. Currently, Regional Water Boards have listed 45 bays and estuaries as impaired for toxic pollutants in sediments or fish tissue and another 124 bays and estuaries as impaired for toxic pollutants for which the effects from sediment are uncertain. There are also a number of impairments of fish and wildlife beneficial uses that Regional Water Boards have not yet identified the source of the pollutants and which could be attributable, at least in part, to pollutant concentrations in sediments.

Incremental Impacts of the Proposed Plan Amendments

The incremental economic impacts of the Plan include the costs of activities above and beyond those that would be necessary in the absence of the Plan under baseline conditions, as well as any cost savings associated with actions that will no longer need to occur (e.g., through more accurate assessment procedures). Note that assessments of impairment, controls, and sediment cleanups to reduce pollution in waters impaired under baseline conditions would continue in the absence of the Plan amendments. Thus, these existing impairments are not incremental impacts associated with the proposed SQO amendments.

Under the Plan, Regional Water Boards would list sediment as exceeding the narrative SQOs for wildlife and finfish if an ecological risk assessment indicates impairment. An ecological risk assessment may reflect any applicable and relevant ecological risk information including policies and guidance from the California Environmental Protection Agency's (Cal/EPA) Office of Environmental Health Hazard Assessment (OEHHA), Cal/EPA's Department of Toxic Substances Control (DTSC), the California Department of Fish and Game, the U.S. Environmental Protection Agency, the U.S. Army Corps of Engineers, the National Oceanographic Atmospheric Administration, and the U.S. Fish and Wildlife Service. The Water Boards will also consult with these agencies when threatened and endangered species are present to ensure that these species are adequately protected. Thus, the proposed Plan amendments could result in greater efforts to assess sediment quality in relation to fish and wildlife beneficial uses, which in turn could result in identification of new impairments or changes to existing impairments. **Exhibit ES-1** indicates the possible outcomes under the proposed Plan amendments.

Exhibit ES-1. Potential Incremental Impacts Associated with the Proposed Plan Amendments

Assessment of Attainment of Existing Beneficial Uses	Assessment Under Proposed SQO	
	Impairment not attributable to sediments	Impairment attributable to sediments
Impairment not attributable to sediments	• No change in sediment quality. • Potential incremental assessment costs.	• Sediment quality improvement. • Potential incremental assessment and control costs.
Impairment attributable to sediments	• Sediment quality remains the same, which may be lower than under implementation of baseline narrative objective. • Potential incremental assessment costs, but will avoid unnecessary control costs.	• Change in sediment quality if better data lead to change in control strategies. • Potential incremental assessment costs; potential incremental costs or cost-savings depending on differences in control strategies.

Monitoring and Assessment Costs

There are already extensive monitoring and assessment activities supporting the baseline regulatory framework. Absent the proposed Plan amendments, these activities will continue, and additional efforts will be undertaken (e.g., as Regional Boards assess compliance with existing objectives for sediment toxicity, and address sites currently impaired for sediment toxicity). That is, data is needed to determine whether sediments are in compliance with existing narrative objectives for sediment toxicity related to fish and wildlife. Similarly, in instances in which sediments exceed baseline objectives for sediment toxicity, assessment of the causes and sources will be needed in order to identify means of compliance with the objectives. These activities, which can include developing a work plan/project management, collecting additional data, conducting ERAs or toxicity identification evaluations (TIEs), surface water modeling, and other analysis, may be conducted as part of developing a TMDL (SCCWRP, 2005; Parsons, et al., 2002, as cited in WSPA, 2007).

SWRCB (2008) provided unit costs for monitoring to assess the SQOs to protect the benthic community (direct effects). Monitoring efforts for ERAs to assess indirect effects to wildlife and finfish beyond the monitoring necessary to assess water quality criteria and the SQOs for direct effects could involve collecting finfish and documenting the presence of deformities, irregularities in size, or population effects, and collection and analysis of wildlife tissue or bird eggs. **Exhibit ES-2** provides unit costs for these types of analyses. Sample collection costs may vary based on factors such as water depth, abundance of fish species, sediment characteristics (may cause unsuccessful grabs that need to be repeated), and distance between stations. Although data for some parameters may not be needed at each sampling site, the total costs per sampling event could be in the range of $7,400 to $11,700.

Exhibit ES-2. Incremental Sampling Costs to Assess Finfish and Wildlife Health[1]

Parameter	Unit Cost	Number per Event	Total Cost
Fish Collection (for sampling or observation)[2]	$1,500 – $1,800 per site	1	$1,500 – $1,800
Metals suite (tissue)	$175 – $225 per sample	6*	$1,050 – $1,350
Mercury (tissue)	$30 – $80 per sample	6*	$180 – $480
Chlorinated pesticides (tissue)	$200 – $575 per sample	6*	$1,200 – $3,450
PCBs suite (tissue)	$575 – $775 per sample	6*	$3,450 – $4,650
Total cost per sampling event	NA	NA	$7,380 – $11,730

Source: SCCWRP (2011) and SWRCB (2011a).
*Three fish per species and two species per site.
1. Incremental to sampling requirements to assess attainment of SQOs for direct effects in bays and estuaries. See SWRCB (2008)
2. Includes boat, materials, and labor for observing fish communities or collecting fish for sampling.

The number of stations needed to assess attainment of the proposed finfish and wildlife SQO for bays and estuaries will vary based on site-specific factors. Based on 5 to 30 sites per water body, depending on area, the State Water Board estimates that statewide monitoring costs to assess attainment of the proposed SQO may range from $5.5 million to $8.8 million.

For bays and estuaries not currently on the 303(d) list for sediment toxicity that would exceed the SQO under the proposed Plan amendments, the next step under the Plan would be a sequential approach to manage the sediment appropriately, including developing and implementing a work plan to confirm and characterize pollutant-related impacts, identify pollutants, and identify sources and management actions (including adopting a TMDL, if appropriate). The cost of this sequential approach will vary depending on a number of factors, including the extent of baseline efforts and studies underway to address other impairment issues, and the number of potential stressors to the area. Note that in the absence of the Plan amendments, Regional Water Boards could identify these waters as exceeding the narrative objectives, and thus incremental impacts associated with TMDL development and pollution controls would be zero.

The State Water Board (2001) estimates that development of complex TMDLs (including an implementation plan) may cost over $1 million. In addition, SWRCB (2003a) indicates that TMDL development and mercury reduction strategy cost for the San Francisco Bay could range from $10 million to $20 million. These estimates provide some indication of incremental costs that could be associated with sequential approaches to managing designated use impairments. Thus, the estimates provide an approximation of the potential magnitude of both costs (incremental listings for sediment contamination) and cost savings (incremental changes to existing listings for sediment contamination resulting from additional information) that may be associated with changes in the identification of impairments under the baseline objectives and the proposed Plan amendments.

Clean up and Control Costs

For waters that Regional Water Boards identify as being impaired based on the wildlife and finfish SQO under the Plan, remediation actions and/or source controls will be needed to bring them into compliance. Many bays and estuaries are already listed for sediment impairments or are exceeding the benthic community or human health SQOs and, therefore, would require controls under baseline conditions. When the baseline controls are identical to the ones that would be implemented for the wildlife and finfish SQO, there is no incremental cost or cost savings associated with the Plan amendments. When the baseline controls differ, there is potential for either incremental costs or cost-savings associated with the Plan amendments.

Because strategies to meet current objectives at many impaired sites are still in the planning stages and the overall effects of implementation strategies are unknown, estimates of incremental costs would be highly speculative. For incremental sediment remediation and/or cleanup activities to be required under the Plan, monitoring data would have to indicate adverse impacts to finfish and wildlife attributable to sediments in areas that would not be designated for clean up under existing objectives. However, it is likely that most sites with sediment conditions that would require cleanup and remediation under the Plan amendments would also exceed current objectives. To the extent that results differ, it is possible that the additional assessment activities under the Plan amendments could lead to cleanup strategies that are more cost effective compared to baseline activities. In addition, based on the implementation plans for existing TMDLs, Regional Water Boards are likely to pursue source controls for ongoing sources and only require remediation activities for historical pollutants with no known, ongoing sources.

If incremental remediation activities are necessary, costs are likely to be very specific to the particular site and project. Sediment remediation and cleanup costs may range from less than $1/cy to over $1000/cy for various alternatives with different feasibility and practicality considerations (SWRCB, 1998). Preliminary estimates for dredging sediments in San Diego Bay suggest that unit costs may range from $100/cy to $200/cy, depending on the volume of sediment removed (SDRWQCB, 2007b).

For an increased source control cost associated with additional pollution controls under the Plan, the concentration of toxic pollutants in discharges would have to meet levels that are more stringent than what is needed to achieve compliance with existing objectives (e.g., since they could have to control based on the benthic community and human health SQOs, narrative Basin Plan sediment objectives, or the CTR water quality criteria). Incremental costs for controls may also result from the identification of additional chemical stressors that are not included in the Phase I SQOs, Basin Plans, or CTR. Since many practices that may be employed under existing TMDLs are applicable for controlling the mobilization of pollutants in general, this situation is also difficult to estimate. For example, the TMDL for pesticides and PCBs in the Calleguas Creek watershed indicates that the BMPs needed to achieve the nutrient and toxicity TMDLs for the watershed would likely reduce pesticides and PCBs to necessary levels as well (LARWQCB, 2005c). Thus, without being able to identify the particular pollutants causing toxic effects to wildlife and finfish, and the development of discharge concentrations needed to achieve the objectives, the needed cleanups and/or controls to achieve those concentrations are site- and pollutant-specific, and therefore, difficult to estimate.

For any situation in which point sources are specifically required to control toxic pollutants to levels that are lower than what would be necessary in the absence of the Plan, it is likely that these facilities would implement source control to eliminate the pollutant from entering their treatment plant or industrial process, or pursue regulatory relief (e.g., a variance), rather than install costly end-of-pipe treatment. However, it is uncertain whether such a situation would arise as a result of the Plan amendments.

For agriculture, Regional Water Boards regulate farmers primarily through the conditional WDR waivers that require compliance with water quality standards. Regional Water Boards may also require farmers to meet more stringent criteria for specific pollutants where necessary (e.g., to meet a TMDL, site-specific objectives). All of the affected Regional Water Boards have narrative objectives that specifically prohibit the discharge of pesticides and/or toxic pollutants that cause detrimental effects in aquatic life or to animals and humans. Thus, even in the absence of the Plan amendments, farmers would be prohibited from causing or contributing to toxicity to wildlife and finfish.

Potential means of compliance for storm water sources include increased or additional nonstructural BMPs (e.g., institutional, education, or pollution prevention practices designed to limit generation of runoff or reduce the pollutants load of runoff); and structural controls (e.g., engineered and constructed systems designed to provide water quantity or quality control). Improving the effectiveness of nonstructural BMPs could be on the order of $26 per household (CSU Sacramento, 2005). Caltrans (2001) reports a range of costs for structural controls based construction costs from several transportation departments and jurisdictions. For example, average detention basin costs are approximately $7,000 and wetlands are $13,000. However, Delaware sand filter costs are approximately $118,000, on average (Caltrans, 2001).

For marinas and boating activities, potential means of compliance may include use of less toxic paint on boats; performing all boat maintenance activities above the waterline or in a lined channel to prevent debris from entering the water; removing boats from the water and clean in a specified location equipped to trap debris and collect wastewater; prohibiting hull scraping or any process that removes paint from the boat hull from being conducted in the water; and developing a collection system for toxic materials at harbors. For example, one marina spent $14,500 on a pollution prevention program in 1999 (MBNEP, 2000), and Carson, et al. (2002) estimated the cost of remaining life hull maintenance for 40 foot length, 11 foot width boats to range from a savings of $1,354 (new boat with nontoxic coating, good performance, and lower prices) to a cost of $6,251 (2.5 year old boat requiring stripping, fair performance, and higher prices). In addition, the cost of a unit that collects water that may contain toxic materials from boating maintenance operations so that it may be sent to the sanitary sewer could cost between $3,200 to $4,500 (Pressure Power Systems, 2007).

Wetlands controls may include aeration, channelization, revegetation, sediment removal, levees, or a combination of these practices. The extent of controls needed and the types of controls are unknown. The Central Valley Regional Water Board (2005b) provides one example of the cost of efforts underway in Anderson Marsh wetland on Cache Creek. Capital costs for controlling methylmercury export from Anderson March may range from $200,000 to $1 million, and O&M costs from $20,000 to $100,000 per year (CVRWQCB, 2005b).

1. Introduction

The State Water Resource Control Board (State Water Board) staff is proposing amendments to the state's Water Quality Control Plan for Enclosed Bays and Estuaries: Part 1 Sediment Quality (the Plan). The amendments include additional sediment quality objectives (SQOs) and implementation procedures that apply to enclosed bays and estuaries in California. This report provides analysis of economic factors related to the Plan amendments.

1.1 Background

In 1989, California amended the Porter-Cologne Water Quality Control Act (Porter-Cologne) to require the State Water Board to develop SQOs as part of a comprehensive program to protect existing and future beneficial uses within enclosed bays and estuaries (Section 13393). In 1991, the State Water Board prepared a work plan for the development of SQOs for enclosed bays and estuaries. This work plan included a schedule and specific tasks to develop direct effects tools that would protect benthic communities, and an element to assess the human and ecological risk in bays and estuaries from pollutants in sediments (indirect effects).

Due to significant delays, in 1999, petitioners filed a lawsuit against the State Water Board for failing, among other things, to adopt SQOs. As a result, the Superior Court ordered the State Water Board to develop SQOs for toxic pollutants as part of the Bay Protection and Toxic Cleanup Program pursuant to California Water Code (CWC) Section 13393 in accordance with a compliance schedule. In 2008, the State Water Board adopted SQOs and an implementation policy for bays and estuaries in the state (Part I of the Plan). 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 includes narrative SQOs for the protection of aquatic life and human health; identification of the beneficial uses that these objectives are intended to protect; and a program of implementation that contains specific indicators, tools, and implementation provisions to determine if the sediment quality at a station or multiple stations meets the narrative objectives, description of appropriate monitoring programs, and 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.

The State Water Board is proposing amendments to the Plan to incorporate additional SQOs for the protection of wildlife and finfish and implementation policy.

1.2 Scope of the Economic Analysis

In establishing water quality objectives, the State Water Board considers economic factors, among others. Specifically, these economic factors include whether the objectives and alternatives under consideration are currently being attained, the methods available to achieve compliance, and the costs of those methods. The State Water Board is considering these same factors in proposing the SQO amendments. Thus, this report addresses whether the SQOs are currently being attained, the incremental impact of the Plan amendments on actions related to improving sediment quality, the pollution control and remediation methods available to achieve compliance the Plan amendments, and the costs of those methods. There may also be cost savings as a result of greater accuracy in identifying contaminated sediments.

The available compliance methods and costs depend on the types of sources that may be affected by the proposed SQOs. Potentially affected sources could include industries and municipal facilities discharging wastewater and storm water to surface waters (i.e., point sources) and nonpoint sources. Entities may also incur costs associated with monitoring and assessment to determine compliance with the objectives.

1.3 Organization of the Report

This report is organized as follows. Section 2 describes the economic and regulatory baseline for estimating the incremental impacts of the SQOs and implementation procedures. Section 3 describes the objectives and implementation procedures, and current attainment of the proposed objectives. Section 4 discusses potential means of compliance with the Plan and estimates of the potential costs of those methods. Section 6 provides a discussion of potential statewide costs and uncertainties of the analysis. Several appendices provide additional information related to the analysis.

2. Baseline for the Analysis

This section describes the baseline for identifying potential economic impacts of the Plan amendments. Baseline conditions include current objectives and policies regulating activities and pollutant discharges that affect sediment quality in bays and estuaries, ongoing sediment cleanup and remediation activities in bays and estuaries, and planned or anticipated actions to address sediment-related and other impairments in bays and estuaries [e.g., total maximum daily load development (TMDL) and implementation schedules].

2.1 Existing Objectives

In 2008, the State Water Board adopted the Water Quality Control Plan for Enclosed Bays and Estuaries: Part 1 Sediment Quality. The Plan is applicable to enclosed bays and estuaries and surficial sediments that have been deposited or emplaced below the intertidal zone. The Plan protects estuarine and marine habitat and rare and endangered species beneficial uses, and commercial and sport fishing, aquaculture, and shellfish harvesting beneficial uses by protecting benthic aquatic life and human health, respectively:

- 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 implemented using the integration of multiple lines of evidence (MLOE).
- Human Health: Pollutants shall not be present in sediments at levels that bioaccumulate in aquatic life to levels that are harmful to human health.

The Plan specifies procedures for implementing the narrative SQOs, including determining compliance, NPDES permitting procedures, and monitoring requirements.

In addition, to the Plan, individual Basin Plans for the nine Regional Water Quality Control Boards (Regional Water Boards), contain sediment toxicity and fish and wildlife protection criteria. None of the Regional Water Boards have adopted numeric objectives for sediments. Rather, the Regional Water Boards rely on narrative objectives to protect and manage ambient sediment quality. The current objectives in each Basin Plan are described in **Appendix A**. The Lahontan (Region 6) and Colorado River Basin (Region 7) Regions do not contain any enclosed bays or estuaries, and thus, are not included in this analysis.

Also, the California Toxics Rule (CTR) contains criteria for toxic pollutants applicable to inland surface waters, enclosed bays, and estuaries in the state. However, Regional Water Boards may adopt more stringent criteria for specific pollutants where necessary (e.g., to meet a TMDL, site-specific objectives). **Appendix B** shows the CTR criteria, and indicates where a Regional Water Board may have more stringent criteria in its Basin Plan.

2.2 Monitoring

Under existing objectives, policies, and programs, there are a wide range of monitoring efforts underway by Regional Water Boards, dischargers, and other organizations to characterize effluent, ambient water, and sediment quality, and fish and wildlife health. These efforts include regional and coordinated programs, as well as discharger monitoring requirements. Regional programs include:

- **Southern California Bight Regional Monitoring Surveys** – managed by the Southern California Coastal Water Research Project to evaluate the physical, chemical and biological impacts to ocean, bay and estuarine waters from Ventura to San Diego. These surveys are performed every 4 to 5 years. The most recent effort, “Bight 08 Survey” included chemical analysis of tissue and sediment, sediment toxicity, analysis of benthic invertebrate and fish community structure, and evaluation of gross pathology in trawl caught fish in a bays and coastal waters.

- **San Francisco Regional Monitoring Program for Trace Substances (RMP)** – managed by the San Francisco Estuary Institute (SFEI) to collect data to evaluate contaminant exposure within the San Francisco Bay ecosystem. Specific studies conducted in 2010 aimed at fish and wildlife exposure and effects include monitoring contaminant bioaccumulation in small fish and bird shells, and assessing sensitivity of terns to PBDEs (SFEI, 2009). The RMP is an annual effort, though individual parameters may be monitored more or less frequently.
- **Surface Water Ambient Monitoring Program (SWAMP)** – State Water Board program to provide decision makers and the public with the information necessary to evaluate surface water quality throughout California. SWAMP supports the collection of high quality data in all regions for 303(d) listing and 305(b) reporting on impaired waterbodies and waters supporting beneficial uses.
- **Mussel Watch Program** – National Oceanic and Atmospheric Administration program of national status and trends. Longest running contaminant monitoring program in the United States. Contaminant concentrations in mussel tissue are a direct measure of exposure for all similar filter feeders in those habitats where found, as well as an indicator of dietary exposure for biota the feed on these filter feeders.
- **Regional Harbors Monitoring Program (RHMP)** – collaborative program initiated in response to Regional Water Board request pursuant to CWC 13255 for water quality information for Dana Point Oceanside, Mission Bay, and San Diego Bay. The objectives of this program include assessing water and sediment quality to sustain healthy biota, and the long-term trends in harbor conditions (Weston, 2008).
- **Central Coast Long-term Environmental Assessment Network (CCLEAN)** – stakeholder program to maintain, restore, and enhance nearshore water and sediment quality and associated beneficial rare, including threatened, or endangered species, water contact recreation, and wildlife habitat uses in the Central Coast Region. CCLEAN satisfies the NPDES receiving water monitoring and reporting requirements of program participants. Concerns center around elevated concentrations of persistent organic pollutants (e.g., petroleum hydrocarbons, chlorinated pesticides, polychlorinated biphenyls) in fish from the Monterey Submarine Canyon, declines in sea otter populations, diseases in sea otters related to high concentrations of persistent organic pollutants, and bird and mammal deaths due to blooms of toxic phytoplankton.

Also, the California Water Quality Monitoring Council (Monitoring Council) has a 2010 plan to assemble the widest collection of water quality data ever available on the state's lakes, rivers, streams, wetlands, and ocean waters.

Indeed, as a result of existing monitoring efforts, there are over 5,000 samples of data related to sediment quality from 42 different agencies, for bays and estuaries in California (Weisberg and Bay, 2007). For example, under the State Water Board's Bay Protection and Toxic Cleanup Program (BPTCP), the San Francisco Bay Regional Water Board conducted a pilot RMP with the SFEI and is continuing participation in the RMP, conducted a fish tissue study to identify contaminant concentrations that would trigger a fish consumption advisory in the San Francisco Bay, and conducted baywide sediment assessments to identify toxic hot spots.

In addition, under the BPTCP, each Regional Water Board identified toxic hot spots in their area using a two step process designed to consider three measures (toxicity testing, benthic community analysis, and chemical analysis), plus an optional bioaccumulation component (SWRCB, 2003b). The first step was a screening phase that consisted of measurements using toxicity tests, benthic community analysis, chemical tests, or bioaccumulation data to provide sufficient information to list a site as a potential toxic hot spot. A positive result in any of the tests triggered the second, confirmation step (depending on available funding) which consisted of testing the previously sampled site of concern for all three measures (SWRCB, 2003b).

Individual dischargers are also required to monitor sediment quality. As described in the fact sheet for the revised tentative order (MS4 permit) for Orange County (SDRWQCB, 2007), the copermittees must conduct monitoring, including chemistry, toxicity, and bioassessment, and use the results to determine if impacts from urban runoff are occurring. If toxic pollutants are present in runoff, the copermittees are required to conduct a Toxicity Identification Evaluation (TIE). A TIE is a set of procedures used to identify the specific chemical or chemicals responsible for toxicity to aquatic organisms. When a TIE results in identifying a pollutant associated with urban runoff as a cause of toxicity, follow-up actions should analyze all potential sources causing toxicity, potential BMPs to eliminate or reduce the pollutants causing toxicity, and suggested monitoring to demonstrate that toxicity has been removed.

2.3 Municipal and Industrial Dischargers

The State Water Board regulates toxic pollutants in the effluents of municipal and industrial wastewater treatment facilities through the National Pollutant Discharge and Elimination System (NPDES) permit program. The Water Boards issue NPDES permits pursuant to section 402 of the Clean Water Act which requires that all point source discharges of pollutants to waters of the United States be regulated under a permit. Under the NPDES permit program, permits contain both technology-based and water quality-based effluent limits (WQBELs). WQBELs reflect applicable water quality standards including those contained in basin plans and the California Toxic Rule.

NPDES permits also reflect narrative objectives contained in basin plans. For example, Section V of the San Francisco Bay Regional Final Order 2010 – 0060 states the discharges shall not cause toxic or other deleterious substances to be present in concentrations or quantities which will cause deleterious effects on wildlife, waterfowl, or other aquatic biota, or which render any of these unfit for human consumption, either at levels created in the receiving waters or as a result of biological concentration in Central San Francisco Bay (SFRWQCB, 2010). These permittees may contribute and support the RMP in which several special studies focus on exposure and effects to fish and wildlife to assess compliance with the receiving water limits. In addition, the City of Los Angeles Terminal Island treatment plant’s NPDES permit (Order R4-2010-0071) contains provisions requiring the discharger to perform a number of special studies related to the protection of fish and wildlife including local demersal fish survey and local bioaccumulation trends survey, and participate in Southern California Bight Regional Demersal Fish and Invertebrate Survey and Regional Predator Risk Survey.

Although, the proposed Plan amendments apply to bays and estuaries, municipal and industrial facilities discharging to tributaries upstream of affected waters could also be a potential source of pollutant loadings to downstream sediments. Based on the Regulated Facilities Report for California, there are 584 individually-permitted NPDES dischargers in the state discharging to inland surface waters, enclosed bays, and estuaries **(Exhibit 2-1**).

Exhibit 2-1. Summary of Individual-Permitted NPDES Dischargers in California

Regional Water Board	Major Dischargers	Minor Dischargers	Total Dischargers
1	15	31	46
2	56	25	81
3	22	17	39
4	45	75	120
5F	7	22	29
5R	14	37	51
5S	37	51	88
6T	1	4	5
6V	2	5	7
7	9	17	26
8	22	12	34
9	40	17	57
Total	270	313	583

Source: SWRCB (2011b).

2.4 Storm Water Dischargers

Regional Water Boards regulate most storm water discharges under general permits. General permits often require compliance with standards through an iterative approach based on storm water management plans (SWMPs), rather than through the use of numeric effluent limits. In other words, permittees implement best management practices (BMPs) identified in their SWMPs. Then, if those BMPs do not result in attainment of water quality standards, Regional Water Boards require additional practices until pollutant levels are reduced to the appropriate levels. Because Regional Water Boards use this iterative approach that increases requirements until water quality objectives are met, current levels of implementation may not reflect the maximum level of control required to meet existing standards (CSU Sacramento, 2005). The State Water Board has four existing programs for controlling pollutants in storm water runoff: municipal, industrial, construction, and California Department of Transportation (Caltrans).

2.4.1 Municipal Discharges

The municipal program regulates storm water discharges from municipal separate storm sewer systems (MS4s). The MS4 permits require the discharger to develop and implement a SWMP, with the goal of reducing the discharge of pollutants to the maximum extent practicable (MEP). MEP is the performance standard specified in Section 402(p) of the Clean Water Act. The management programs specify the BMPs to be used to address public education and outreach; illicit discharge detection and elimination; construction and post-construction; and good housekeeping for municipal operations. In general, medium and large municipalities must conduct chemical monitoring, though small municipalities do not.

There are currently 22 Phase I MS4 permits in California with discharges to bay and estuaries. These permits can include actions addressing sediment quality. For example, the Contra Costa Clean Water Program (CA0029912 and CA0083313) requires the permittees to pursue a mass emission strategy to reduce pollutant discharges from point and nonpoint sources and address accumulation of pollutants in organisms and sediments (SFRWQCB, 1999). Municipalities may also be required to monitor to assess whether the discharges contribute to exceedances of narrative criteria. For example, similar to the wastewater dischargers to the San Francisco Bay, municipal stormwater agencies are provided flexibility associated with monitoring requirements under Order No. R2-2009-0074 which also requires receiving water monitoring and participation within the RMP to assess receiving water quality; specific provisions require monitoring of water column and sediment toxicity, benthic invertebrates (bioassessment) and sediment bound toxic pollutants DDT, PCBs, copper, mercury, selenium to assess effectiveness DDT. The Alameda Countywide Clean Water Program (CAS0029831) requires tracking of mercury trends in sediment (Alameda, 2003).

In addition, there are 209 small MS4s that have submitted SWMPs to Regional Water Boards or the State Water Board for approval. However, it is not clear how many of those MS4s discharge to enclosed bays and estuaries.

2.4.2 Industrial Discharges

Under the industrial program, the State Water Board issues a general NPDES permit that regulates discharges associated with ten broad categories of industrial activities. This general permit requires the implementation of management measures that will achieve the performance standard of best available technology economically achievable (BAT) and best conventional pollutant control technology (BCT). The permit also requires that dischargers develop a Storm Water Pollution Prevention Plan (SWPPP) and a monitoring plan. Through the SWPPP, dischargers are required to identify sources of pollutants, and describe the means to manage the sources to reduce storm water pollution. For the monitoring plan, facility operators may participate in group monitoring programs to reduce costs and resources.

2.4.3 Construction

The construction program requires dischargers whose projects disturb one or more acres of soil or whose projects disturb less than one acre but are part of a larger common plan of development that in total disturbs one or more acres to obtain coverage under the a general permit for discharges of storm water associated with construction activity. The construction general permit requires the development and implementation of a SWPPP that lists BMPs the discharger will use to protect storm water runoff and the placement of those BMPs. Additionally, the SWPPP must contain a visual monitoring program; a chemical monitoring program for nonvisible pollutants to be implemented if there is a failure of BMPs; and a sediment monitoring plan if the site discharges directly to a water body impaired for sediment.

2.4.4 Caltrans

In 1996, Caltrans requested that the State Water Board consider adopting a single NPDES permit for storm water discharges from all Caltrans properties, facilities, and activities that would cover both the MS4 requirements and the statewide construction general permit requirements. The State Water Board issued the Caltrans general permit in 1999, requiring Caltrans to control pollutant discharges to the MEP for the MS4s and to the standard of BAT/BCT for construction activities through BMPs. The State Water Board also requires dischargers to implement more stringent controls, if necessary, to meet water quality standards.

2.5 Nonpoint Sources

Nonpoint source pollution, unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources. Some nonpoint source pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, depositing them into lakes, rivers, wetlands, coastal waters, and groundwater. Nonpoint source pollution may originate from several sources including agricultural operations, forestry operations, urban areas, boating and marinas, active and historical mining operations, atmospheric deposition, and wetlands. Note that, in many cases, discharges from these sources can be regulated as point sources (i.e., discernible, confined, and discrete conveyances).

In 1999, California implemented its Fifteen-Year Program Strategy for the Nonpoint Source Pollution Control Program, as delineated in the Plan for California's Nonpoint Source Pollution Control Program (NPS Program Plan). The legal foundation for the NPS Program Plan is the Clean Water Act (CWA) and the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA) (SWRCB, 2000). The agencies primarily responsible for the development and implementation of the NPS Program Plan are the State Water Board, the nine Regional Water Boards, and the California Coastal Commission (CCC). Various other federal, state, and local agencies have significant roles in the implementation of the NPS Program Plan.

Federal approval and funding of the NPS Program Plan required assurance the state had legal authority to implement and enforce the plan. The state's Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program (NPS Policy) provides guidance regarding the implementation and enforcement of the NPS Program Plan. As stated in the NPS Policy, the Porter-Cologne Act provides the legal authority of the State Water Board and Regional Water Boards to regulate nonpoint sources in California under waste discharge requirements (WDRs), conditional waivers of WDRs, or basin plan prohibitions or amendments (SWRCB, 2004b). However, all WDRs need not contain numeric effluent limits. The Regional Water Boards do not usually assign nonpoint sources numeric effluent limits; rather they primarily rely on implementation of BMPs to reduce pollution.

The NPS Program Plan specifies management measures (MMs) and the corresponding management practices or BMPs for each of six source categories. MMs should be implemented where needed by 2013 using a combination of nonregulatory activities and enforceable policies and mechanisms (SWRCB, 2003a). **Appendix C** describes the MMs for each source category applicable to sediment toxicity reductions.

2.5.1 Agriculture

Impacts from agricultural activities that may affect sediment quality include sedimentation and the runoff of pesticides. These impacts can be caused by:

- Farming activities that cause excessive erosion, resulting in sediment entering receiving waters
- Improper use and overapplication of pesticides
- Overapplication of irrigation water resulting in runoff of sediments and pesticides (SWRCB, 2006b).

Although wastewater discharges from irrigated land including storm water runoff, irrigation tailwater, and tile drainage are subject to regulation under WDRs, Regional Water Boards have historically regulated these discharges under waivers. These waivers are authorized by CWC Section 13269 which allows Regional Water Boards to waive WDRs if it is in the public interest.

Most historical waivers require that discharges not cause violations of water quality objectives; however, do not require water quality monitoring. In 1999, Senate Bill 390 amended CWC Section 13269 and required Regional Water Boards to review and renew their waivers, or replace them with WDRs. If Regional Water Boards did not reissue the waivers by January 1, 2003 they expired. The Central Coast, Los Angeles, Central Valley, and San Diego Regional Water Boards have established conditional waivers for agricultural discharges. The Santa Ana Regional Water Board is in the process of developing a conditional waiver for discharges from irrigated agricultural lands. While the North Coast and San Francisco Bay Regional Water Boards have no immediate plans to adopt waivers for agricultural discharges, they may do so in the future in the context of TMDLs.

In conjunction with conditional waivers, Regional Water Boards regulate agricultural discharges from cropland under nonpoint source programs that rely on BMPs to protect water quality. For example, the State Water Board and the CCC oversee agricultural control programs, with assistance from the Department of Pesticide Regulation (DPR) for pesticide pollution and the Department of Water Resources for irrigation water management (SWRCB, 2006b).

The pesticide management measure (MM 1D) is likely to have the greatest impact on sediment toxicity. This MM reduces contamination of surface water and ground water from pesticides through:

- Development and adoption of reduced risk pest management strategies (including reductions in pesticide use)
- Evaluation of pest, crop, and field factors
- Use of Integrated Pest Management (IPM)
- Consideration of environmental impacts when choosing pesticides for use
- Calibration of equipment
- Use of antibackflow devices (SWRCB, 2006b).

IPM is a key component of pest control. IPM strategies include evaluating pest problems in relation to cropping history and previous pest control measures, and applying pesticides only when an economic benefit will be achieved. Pesticides should be selected based on their effectiveness to control target pests and their potential environmental impacts such as persistence, toxicity, and leaching potential (SWRCB, 2006b).

There are many planned, on-going, and completed activities related to management of pesticides. However, as reported in the most recent NPS Program Plan progress report (SWRCB, 2004a), efforts to improve water quality impaired by agriculture activities are highly challenging because of the different perspectives that exist between the regulatory community and the agricultural community.

As of 2003, the SWRCB (2004a) reports the following progress:

- 16 watershed working groups are actively developing farm water quality plans, with 19 new groups being formed
- Of the over 90 farmers that attended a Farm Water Quality Course, half have developed comprehensive water quality plans for more than 10,700 acres of irrigated crops
- Over 750 farmers have attended 35 workshops designed to train farmers in specific conservation practices.

2.5.2 Forestry

Timber harvesting and associated activities can result in the discharge of chemical pollutants and petroleum products, in addition to other conventional pollutants. Chemical pollutants and metals can be discharged through runoff and drift. Potential sources of chemical runoff include roads that have been treated with oils or other dust suppressing materials and herbicide applications.

Forest chemical management focuses on reducing pesticides that are occasionally used for pest management to reduce mortality of desired tree species, and improve forest production. Pesticide use on state or private forestry land is regulated by DPR. However, a large proportion of California's forested lands are owned or regulated by the federal government (SWQCB, 2004a) in which pesticide use is controlled by the USDA Forest Service Region 5.

In addition to the NPS Program Plan MMs, forestry activities are also controlled through WDR and conditional waivers. Recently, Regional Water Boards have adopted waivers for timber harvesting activities, provided that the activities comply with the general conditions listed in each waiver, including compliance with applicable requirements contained in each Region's basin plans.

The DPR regulates the sale and use of pesticides and, through county agricultural commissioners (CACs), enforces laws pertaining to pesticide use. CACs inspect pesticide applications to forests and ensure that applications do not violate pesticide laws and regulations. Landowners must also submit timber harvest plans (THPs) to the California Department of Forestry (CDF) outlining what timber will be harvested, how it will be harvested, and the steps that will be taken to prevent damage to the environment. CDF will only approve those THPs that comply with all applicable federal and state laws.

The Forest Practices Act provides a conditional exemption from WDRs for timber operations (article 1. section 4514.3). The Forest Practice Rules establish responsible forest resource management practices which serve the demand for timber and other forest products, while giving consideration to the public's need for watershed protection, fisheries, and wildlife and recreational opportunities.

2.5.3 Urban Runoff

Pollutants found in runoff from urban areas include, among others, sediments, heavy metals, petroleum hydrocarbons, and plastics. As population densities increase, pollutant loadings generated from human activities also increase. Most urban runoff enters surface waters without undergoing treatment.

The control of urban nonpoint pollution requires the use of two primary strategies: preventing pollutant loadings from entering waters and reducing the impact of unavoidable loadings. The major opportunities to control nonpoint loadings occur during the following three stages of development: (1) the siting and design phase, (2) the construction phase, and (3) the post-development phase. Before development occurs, land in a watershed is available for a number of pollution prevention and treatment options, such as setbacks, buffers, or open space requirements, as well as wet ponds or constructed urban runoff wetlands that can provide treatment of the inevitable runoff and associated pollutants. In addition, siting requirements and restrictions and other land use ordinances, which can be highly effective, are more easily implemented during this period. After development occurs, these options may no longer be practicable or cost-effective.

Urban runoff is addressed primarily through the NPDES program, although the State Water Board NPS Program Plan applies where runoff is not regulated as a permitted point source. The NPDES program supersedes the State Water Board and Regional Water Board NPS Program in the areas where there is overlap. NPDES permits require implementation of BMPs, which may or may not be similar to the MMs in the NPS Program.

In 1976, the State Legislature enacted the California Coastal Act (CCA) to provide for the conservation and planned development of the State's coastline. The CCA directs each of the 73 coastal cities and counties to prepare, for review and certification by the CCC, a local coastal plan (LCP) consisting of land use plans, zoning ordinances, zoning district maps, and, other implementation actions. The CCC also works with local governments to incorporate urban MMs and MPs into their respective LCPs. Certified LCPs are important tools for implementing urban runoff MMs and MPs that prevent, reduce or treat polluted runoff from proposed developments. Storm water programs can become more effective because of local planning and permitting decisions throughout the State.

2.5.4 Marina and Recreational Boating

Poorly planned or managed boating and related activities (e.g., marinas and boat maintenance areas) may threaten the health of aquatic systems and pose other environmental hazards. There are nearly 1 million registered boats and approximately 650 marinas in California (SWRCB, 2004a). Boats repairs, fouling and corrosion control, and sanding, scraping, painting, varnishing and fiberglassing boats can result in pollutants such as metals, solvents, hydrocarbons and other contaminants entering surface waters (Hunt and Doll, 2007). For example, copper and zinc are often found in marina sediments due to the leaching of antifoulant paints.

Note that commercial and military ports are subject to storm water NPDES permits regulating industrial and construction activities. Commercial ports are also required to submit a port master plan to the CCC. The master plan must include an estimate of the effect of development on habitat areas and the marine environment, a review of existing water quality, habitat areas, and quantitative and qualitative biological inventories, and proposals to minimize and mitigate any substantial adverse impact. In addition, the state has the opportunity to ensure that appropriate pollution prevention and control measures are in place at all military ports.

There are many planned, on-going, and completed activities related to nonpoint source pollution in marinas. The primary focus of these activities is to prevent discharges of waste oil, sewage, petroleum, solid waste, and toxic pollutants from surface runoff, improper boat cleaning/maintenance activities, lack of disposal facilities, or improper maintenance of facilities at marinas (SWRCB, 2006b). For example, the compliance schedule for the Dissolved Copper in Shelter Island Yacht Basin (SIYB), San Diego Bay TMDL consists of a 17-year staged schedule period. The first stage consists of an initial 2-year orientation period. The subsequent 15-year reduction period will achieve the incremental copper load reductions by requiring all new boats entering SIYB to have nontoxic or less toxic coatings, and through replacement of copper coatings on all existing boats with a nontoxic or less toxic coating at the next time routine hull stripping is scheduled (SDRWQCB, 2005).

The state is also relying on education and outreach efforts aimed at marina owners and operators, and the boating public, to provide information on pollution problems and management practices that can be implemented to prevent or control improper disposal of pollutants into surface waters (SWRCB, 2006b). For example, the Boating Clean and Green Campaign provides statewide boater education and technical assistance program, conducted by the CCC in partnership with the California Department of Boating and Waterways, to promote environmentally sound boating practices. Issues addressed through the Campaign include vessel cleaning and maintenance, handling and disposal oil and fuel, handling and disposal of hazardous materials, and proper disposal of trash and gray water. A California Clean Marina Toolkit is available to assist marine operators in identifying clean marina practices and resources that will help to implement these practices (CCC, 2004).

The Federal Oil Pollution Act (OPA) is a comprehensive prevention, response, liability, and compensation regime for dealing with vessel- and facility-generated discharges of oil or hazardous substances. Under the OPA, any hazardous waste spill from a vessel must be reported by the owner of the vessel, and vessel owners are responsible for any costs of a resulting environmental cleanup and any damage claims that might result from the spill. Marinas are responsible for any oil contamination resulting from their facilities, including dumping or spilling of oil or oil-based paint and the use of chemically treated agents. The California Department of Fish and Game's Office of Spill Prevention and Response enforces the laws designed to prevent spills, dispatches units to respond to spills, and investigates spills.

2.5.5 Abandoned and Inactive Mines

The State Water Board and Regional Water Boards have identified approximately 40 mines that cause serious water quality problems resulting from acid mine drainage and acute mercury loading (SWRCB, 2000). Although all mines may not be significant polluters individually, cumulatively mines may contribute to chronic toxicity due to increased metals loadings. Additionally, drainage structures and sluices associated with abandoned hydraulic gold mines are a potential source of mercury to surface waters. Mercury from abandoned mines poses a serious potential threat to coastal waters because mercury transported from these sites may bioaccumulate in fish.

The NPS Program Plan does not contain management measures for abandoned mines, and there is no specific, comprehensive program at either the state or federal level for cleaning up abandoned and inactive mines other than coal. Rather, abandoned and inactive mine cleanup is carried out under a variety of state, federal, and local programs. Regional Water Boards may issue WDRs to the most serious sites. The federal Superfund Program addresses only the most extreme pollution sites, such as Iron Mountain Mine. Federal land management agencies have specific, marginally funded programs for cleaning up abandoned mines on federal land, but most projects address safety hazards rather than water quality. California's Title 27 Program regulates discharges of wastes to land, and can be used to pursue mine cleanups.

Enforcement actions, however, are costly and have not been effective because responsible parties are difficult to locate, and current property owners either do not have, or will not spend money, to cleanup their sites. The main barrier to a comprehensive program for abandoned mines is liability (SWRCB, 2003a). Under the federal CWA, a third party can sue an agency or private party that performs abatement actions at an abandoned mine if the discharge from the mine continues to violate the CWA.

In June 2000, the California Department of Conservation (DOC) inventoried the number of abandoned mine sites and features located in the state. DOC estimates that of the 47,084 historic and inactive mine sites in the state, approximately 11% (5,200) present an environmental hazard. The most common hazards include heavy metals from acid rock drainage and methylmercury from mercury contaminated sediments. DOC (2000) indicates that some bays have been or could be impacted by acid rock drainage and mercury from abandoned mines.

As a land-managing agency, the U.S. Forest Service (USFS) also has an abandoned mine reclamation program. The program includes an inventory of abandoned mines and locations, environmental and/or resource problems present, rehabilitation measures required, and potential sources of funding. The USFS has worked with various Regional Water Boards on numerous occasions in the rehabilitation of mine sites. Restoration funding comes from USFS funds, the Comprehensive Environmental Response and Compensation Liability Act, and Resource Conservation and Recovery Act sources. All lands disturbed by mineral activities must be reclaimed to a condition consistent with resource management plans, including air and water quality requirements (SWRCB, 2000; SWRCB 2003a).

All active mining projects must comply with the federal Surface Mining and Reclamation Act (SMARA). The goal of SMARA is to have mined lands reclaimed to a beneficial end use. Local Enforcement Agencies (LEAs), usually counties, implement SMARA. The DOC’s Office of Mine Reclamation provides technical support to LEAs but has limited enforcement authority.

Mining projects that could impair water quality or beneficial uses may also be subject to NPDES permits or conditions under the CWA section 401 Water Quality Certification Program.

2.5.6 Atmospheric Deposition

Atmospheric deposition may be a potential nonpoint source to bays through either direct or indirect deposition. Indirect deposition reflects the process by which metals and other pollutants such as PAHs deposited on the land surface are washed off during storm events and enter surface water through storm water runoff (LARWQCB, 2005a). For example, Sabina, et al. (2005) concluded that atmospheric deposition potentially accounts for as much as 57–100% of the total trace metal loads in storm water within Los Angeles. In LARWQCB (2005a) and LARWQCB (2005b) loadings associated with indirect atmospheric deposition are included in the storm water waste load allocations. Therefore, nonpoint source pollution from atmospheric deposition is not directly addressed, but indirectly addressed through storm water management. Typically, direct deposition accounts for a very small fraction of nonpoint source pollution (for example, see LARWQCB, 2005a and LARWQCB, 2005b).

2.5.7 Wetlands

Seasonally and permanently flooded wetlands are sites for methylmercury production due to the presence of sulfate-reducing bacteria in wetland environments (CVRWQCB, 2005a). Wetlands can be significant sources of methylmercury production; for example, the Central Valley Regional Water Board (2005c) estimated that 21,000 acres of wetland in the Sacramento-San Joaquin River Delta produce about 16% of the annual methylmercury load to the watershed. A complicating issue is that wetland restoration efforts are ongoing because wetlands provide important services for ecosystems and human communities.

Management practices to reduce methylmercury discharge could include aeration, changing the stream channel, revegetation, sediment removal, and levees. Some of these practices may be applied upstream to reduce inorganic mercury in water flowing into the wetland, thus reducing methylmercury formation. Other practices may reduce the downstream transport of methylmercury formed in the wetland (CVRWQCB, 2005b).

2.6 Current Impaired Waters

Under the CWA, Section 303(d), states are required to develop a list of water quality limited segments, establish priority rankings for the segments, and develop action plans, or TMDLs, to improve water quality. The listing policy identifies the factors and information that shall by used by the State and Regional Boards to list and delist a water body. Factors applicable to pollutants that bioaccumulate from sediment into fish at concentrations that could be toxic to fish and wildlife include:

- Bioaccumulation of pollutants in muscle or whole body exceeds pollutant specific guideline using the binomial distribution
- Other evaluation guidelines that are:
    - Applicable to the beneficial use
    - Protective of the beneficial use
    - Linked to the pollutant under consideration
    - Scientifically-based and peer reviewed
    - Well described
    - Identifies a range above which impacts occur and below which no or few impacts are predicted. For non-threshold chemicals, risk levels shall be consistent with comparable water quality objectives or water quality criteria.
- Adverse Biological Response in resident organisms compared to reference conditions and associated elevated sediment chemistry. Adverse biological response may include
    - Reduction in growth
    - Reduction in reproductive capacity,
    - Abnormal development,
    - Histopathological abnormalities
    - Other adverse conditions including fish or bird kills
- Degradation of biological populations and communities compared to reference conditions and associated elevated sediment chemistry
- Situation-specific weight of evidence listing factor

For each listing, the Listing Policy directs the Water Boards to identify the pollutant causing degradation of the beneficial uses, a total maximum daily load (TMDL) completion date, and whether a total maximum daily load is required or whether existing programs can be applied to restore the beneficial use.

Exhibit 2-2 summarizes the current impairments for bays and estuaries in California. Appendix D shows the complete list of impairments by water body.

Exhibit 2-2. Summary of Current 303(d) List for Toxics for Bays and Estuaries in California

Regional Board	Number of Water Acres[1]				Number of Water Miles[1]		
	Sediment	Tissue	Water[2]	Total	Sediment	Water[2]	Total
1	-	-	16,075	16,075	-	-	-
2	757	-	392,710	393,467	-	0.6	0.6
3	155	-	29,681	29,836	-	0.03	0.03
4	163,115	155,807	16,486	335,408	1	34	35
5	-	-	43,629	43,629	-	21	21
8	2,063	623	2,063	4,749	-	11	11
9	207	-	13,240	13,447	-	0.8	0.8
Total	166,297	156,430	513,884	836,611	1	67	68

Source: SWRCB (2010).
1. Acres and miles are not unique to medium (i.e., water bodies may be impaired for sediment, tissue, and water)
2. Assumed impairment is for water where sediment or tissue is not specified explicitly.

There are also a number of toxics 303(d) listings for waters upstream of affected bays and estuaries (see SWRCB, 2010). Impaired sediments can be carried downstream and settle into bays and estuaries, contributing to existing impairments or causing new impairments.

Under the existing listing policy, Regional Water Boards may remove waters from the 303(d) list, or delist, if sediment toxicity or associated sediment quality guidelines are no longer exceeded. Regional Water Boards can delist waters if, using the binomial distribution, the number of measured exceedances supports rejection of the null hypothesis. Regional Water Boards may also remove waters from the list if objectives or standards are revised and the site or water meets the revised standards.

2.7 Sediment Cleanup and Remediation Activities

There are a number of sediment cleanup and remediation programs and activities planned or currently underway in California.

2.7.1 Bay Protection and Toxic Cleanup Program

The State Water Board established the Bay Protection and Toxic Cleanup Program (BPTCP) to implement the requirements of Chapter 5.6 of the CWC. Section 13394 of Chapter 5.6 requires the State Water Board and the Regional Water Boards to develop a Consolidated Toxic Hot Spots Cleanup Plan (Consolidated Plan). The Consolidated Plan identifies and ranks known toxic hot spots based on a two-step process using three lines of evidence, and presents descriptions of toxic hot spots, actions necessary to remediate sites, the benefits of remediation, and a range of remediation costs. The plan is applicable to point and nonpoint source discharges that Regional Water Boards reasonably determine to contribute to or cause the pollution at toxic hot spots.

The Consolidation Plan requires Regional Water Boards to implement the remediation action to the extent that responsible parties can be identified, and funds are available and allocated for this purpose. When the

Regional Water Boards cannot identify a responsible party, the Consolidation Plan indicates that they are to seek funding from available sources to remediate the site. The Regional Water Boards determine the ranking of each known toxic hot spot based on the five general criteria specified in the Consolidation Plan as shown in **Exhibit 2-3**.

Exhibit 2-3. Toxic Hot Spot Ranking Criteria

Criteria Category	High	Moderate	Low
Human Health Impacts	Human health advisory for consumption of nonmigratory aquatic life from the site	Tissue residues in aquatic organisms exceed FDA/DHS action level or U.S. EPA screening levels	None
Aquatic Life Impacts[1]	Hits in any two biological measures if associated with high chemistry	Hit in one of the measures associated with high chemistry	High sediment or water chemistry
Water Quality Objectives	Objectives exceeded regularly	Objectives occasionally exceeded	Objectives infrequently exceeded
Areal Extent of Hot Spot	More than 10 acres	1 to 10 acres	Less than 1 acre
Natural Remediation Potential	Unlikely to improve without intervention	May or may not improve without intervention	Likely to improve without intervention

Source: SWRCB (2003b).
1. Rank based on analysis of sediment chemistry, sediment toxicity, biological field, water toxicity, TIEs, and bioaccumulation.

Appendix E provides additional information on the enclosed bays listed as known toxic hot spots in the Consolidated Plan, including ranking and reason for listing. **Exhibit 2-4** provides a summary of the remedial actions and estimated costs for the high priority toxic hot spots. Note that several of the remedial actions identified by the State and Regional Water Boards only characterize the problem at a hot spot. Thus, the costs identified for those actions do not include all actions necessary to fully remediate the toxic hot spot. Additional funds would be required for remediation after characterization studies are complete.

Exhibit 2-4. Summary of Actions and Costs to Address High Priority Known Toxic Hot Spots

Site	Source	Remedial Actions and Estimated Costs to Remediate Site
Delta Estuary, Cache Creek	• Exports from Placer gold mines • Mercury mining in the Coast Range • Resuspension of estuarine sediment • Effluent from municipal and industrial discharges to surface waters.	• Studies to develop mercury control strategy: • Fish eating bird & egg studies plus OEHHA coordination: $335,000 • Mercury monitoring: $1,120,000 • Mine remediation feasibility studies: $150,000 • Estuarine mercury studies: $1,500,000
Delta Estuary, Entire Delta	• Application of diazinon as a dormant orchard spray in the agricultural areas of the Central Valley	• RWB oversight: $400,000 FY 2002-2003 • Other oversight: $200,000 FY 2003-2004 • Costs to growers: $180,000-$600,000/yr • Implementation of practices: $0-$300,000/yr • Regulatory compliance: $3-$164/acre • Continued practices development: $1,000-$4,060/grower/yr • Monitoring: $100,000 to $1 million/yr.

Exhibit 2-4. Summary of Actions and Costs to Address High Priority Known Toxic Hot Spots

Site	Source	Remedial Actions and Estimated Costs to Remediate Site
Delta Estuary, Morrison Creek, Mosher, 5-Mile, Mormon Slough, and Calaveras River	• Urban runoff	• Rainfall evaluation: $50,000/ yr for 3 years • Monitoring urban dischargers: $50,000/yr • Continued practices evaluation: $50,000 to $100,000 for cities annually • Implementation of practices: No additional cost • Regulatory agency oversight: $20,000/yr • Develop TMDL: $50,000/yr until 2005 • Basin Plan amendment: $50,000/yr for 2 years.
Delta Estuary, Ulatis Creek, Paradise Cut, French Camp, and Duck Slough	• Agricultural use	• Basin Plan proposal: $100,000 FY 2002-2003 • R5 oversight: $100,000 FY 2003-2004 • Other oversight: $540,000 -$1.8 million/yr • Costs to growers: $0-$300,000/yr • Implement practices: $2,695-$27,555/grower • Regulatory compliance: $555 - $8,200/grower/yr • Continued practices development: $100,000 - $1million/ yr • Monitoring: $100,000/yr in Delta only.
Humboldt Bay, Eureka Waterfront H Street	• Scrap metal facility including disassembly, incineration, and crushing of autos • Storage of metals, batteries, radiators, metal reclamation from electrical transformers and miscellaneous refuse	• Removal of polluted soils and capping of site: $500,000 - $5,000,000, based on a $500/ton cost for hauling and tipping fees at a hazardous waste disposal site
LA Inner Harbor, Dominguez Channel/ Consolidated Slip	• Historical discharge of DDTs, PCBs, metals • Spills, vessel discharges, anti fouling paints, and storm drains • Waste streams from refineries	• Dredging and offsite disposal of polluted sediments: $1,000,000 - $5,000,000 • Treatment of polluted sediments: $5,000,000 - $50,000,000
LA Outer Harbor, Cabrillo Pier	• Historical discharge of DDTs, PCBs • Discharge of wastewater effluent from Terminal Island WWTP • Nonpoint sources including ship spills, industrial facilities, and storm water runoff	• Dredging and offsite disposal of polluted sediments: $500,000 - $5,000,000 • Capping: $500,000 - $1,000,000 • Treatment of polluted sediments: $2,500,000 - $50,000,000
Lower Newport Bay, Rhine Channel	• Boat yard operations	• Sediment removal: $231,800 • Offsite transport: $4,600,000 • Disposal in a Class I facility: $5,750,000
Moss Landing Harbor and Tributaries	• Past and present agricultural activities • River and stream maintenance activities • Ship maintenance • Urban runoff	• RWB Management: $925,000 (over 5 yrs) • Control of harbor pollutants: $348,334 • Urban runoff action plan: $1,052,750 • Agricultural BMPs: $6,790,000 • Monitoring: $678,000
Mugu Lagoon east arm, Main Lagoon, western arm Calleguas Creek Tidal Prism	• Agricultural runoff, nonpoint source runoff	• In situ treatment of polluted sediment: $72,500,000 • Dredging and removal of polluted sediments: $1,000,000 - $5,000,000
San Diego Bay, Seventh St. Channel Naval Station	• Industrial activities • Pesticides from lawns, streets and buildings • Runoff from pest control operations • Atmospheric deposition	• Dredging and upland disposal: $3,384,800 - $7,405,200 • Dredging and contained aquatic disposal: $145,520 - $275,880

Exhibit 2-4. Summary of Actions and Costs to Address High Priority Known Toxic Hot Spots

Site	Source	Remedial Actions and Estimated Costs to Remediate Site
San Francisco Bay, Castro Cove	• Refinery operations	• Site investigation and feasibility study: $2,000,000 • Dredging with upland disposal and capping: $1,000,000 - $20,000,000 • Regional Water Board staff cost: $200,000
San Francisco Bay, Entire Bay	• Mercury mining runoff and use in placer and hydraulic gold mining operations • Historic industrial use of PCBs	• Cleanup New Almaden Mine: $10,000,000 • Point Potrero cleanup: $800,000-3,000,000 • TMDLs adoption and mercury strategy: $10,000,000 - $20,000,000 • Watershed investigations to identify sources: $4,000,000/5 yrs • Regional Monitoring Plan studies: $75,000/yr; $150,000/2 yrs; then $50,000/yr • Public education on source control and product substitution: $50,000
San Francisco Bay, Islais Creek	• Storm water or urban runoff entering directly or through combined sewer overflows • Sheet runoff or past discharge from auto dismantlers and metal recycling facilities Deposition of air emissions from I-280	• Site investigation and feasibility study: $1,000,000 • Remediation including dredging with follow-up monitoring: $800,000 - $5,200,000 • Change operation or increase storage and capacity of the current system: $75,000,000 • RWB staff costs: $100,000 - $200,000
San Francisco Bay, Mission Creek	• Historic sources • Storm water entering directly or through infrequent combined sewer overflows • Deposition of air emissions from I-280	• Site investigation and feasibility study: $1,000,000 • Remediation including dredging/capping or off site disposal and monitoring: $800,000 - $1,800,000 • Increase storage and structural changes: $75,000,000 • RWB staff costs: $100,000 - $200,000
San Francisco Bay, Peyton Slough	• Historical industrial activity associated with the creation of cinder/slag piles	• Dredging and disposal of 12,000 cubic yards of sediments, and a 3 foot cap on the entire slough: $400,000 - $1,200,000 • Follow-up monitoring: $5,000 - $10,000 per yr • RWB staff costs: $10,000 - $50,000
San Francisco Bay, Point Potrero/ Richmond Harbor	• Historical ship building and scrapping operations • Metal scrap recycling operations	• Sheetpile bulkhead, capping, and institutional controls: $792,000 • Rock Dike bulkhead capping and institutional controls: $1,344,000 • Excavation and off-site disposal: $3,010,000 • Excavation reuse or disposal on site: $881,000 • Regional Water Board costs: $30,000/3yrs
San Francisco Bay, Stege Marsh	• Oxidation of pyrite cinders in presence of sulfides produced during industrial process • Urban runoff • Upland industrial facilities	• Site investigation and feasibility study and remediation option: $1,500,000 to $10,000,000 • RWB costs: $100,000-$200,000
Santa Monica Bay, Palos Verdes Shelf	• Historical wastewater discharges from manufacturing operations • Wastewater treatment plant discharges	• Capping 7.6 sq. km with 45 cm isolation cap: $44,000,000 - $67,000,000 • Capping 7.6 sq. km with 15 cm isolation cap: $18,000,000 - $30,000,000 • Capping most polluted area 4.9 sq. km with 15 cm. isolation cap: $13,000,000 - $19,000,000

Source: SWRCB (2003b). Year dollars not specified.

2.7.2 TMDLs

There are a number of TMDLs in the state that set load limits for pollutant in sediments or target protection on fish and wildlife. For example, the San Francisco Bay Regional Water Board recently adopted two TMDLs to address bay-wide exceedances of the narrative bioaccumulation objective caused by excessive levels of methylmercury and PCBs in fish tissue (SFRWQCB 2006; 2008). The Regional Water Board determined that high mercury levels in sediments are due, in large part, to legacy gold mining operations which have resulted in bay-wide fish consumption advisories. The Regional Water Board derived the mercury targets from the estimated reduction in mercury mass in tissue that would be needed to be protective of human health and wildlife (SFRWQCB, 2006). The U.S. Fish and Wildlife Service performed an ecological risk assessment on the methylmercury tissue criteria to confirm that the TMDL target concentration was protective of rare and endangered species in California. Unlike mercury, the movement of PCBs and other hydrophobic organochlorine compounds up through the food web can be predicted with food web models. The Regional Water Board developed targets for PCBs based on human health risk, however, they also determined that harbor seals and birds such as cormorants and terns would also be protected (SFRWQCB, 2007).

Other examples include the Santa Ana River Region's effort underway to develop a TMDL and site specific objective (SSO) to protect wildlife from exposure to selenium that has accumulated in fish tissue and egg shells. The technical workgroup has begun to identify relevant and appropriate endpoints and targets that protect wildlife in the waterbody.

As part of a TMDL, Regional Water Boards identify potential implementation strategies and estimate the cost of implementation. However, Porter-Cologne prohibits Regional Water Boards from prescribing the exact method of achieving compliance with the targets. Thus, there is no requirement to follow the proposed strategies as long as the allowable loadings are not exceeded.
Although sources are not required to follow the proposed strategies, the recommendations provide an idea of the types of activities that could be necessary for compliance with baseline standards.

In certain cases, implementation activities may not vary based on the pollutant. For example, storm water BMPs designed to remove a specific metal could be used to remove all metals. Implementation activities for the Calleguas Creek metals and organochlorine pesticides and PCBs TMDLs include:

- Establish group concentration-based effluent limits for NPDES dischargers
- Implement BMPs for nonpoint sources consistent with the Nonpoint Source Plan and Conditional Waiver Program.
- Develop Agricultural Water Quality Management Plans and implement agricultural BMPs based on results of BMP effectiveness studies
- Develop agricultural education program to inform growers of the recommended BMPs and the Management Plan.

Implementation plans may also include additional studies to better determine pollutant sources, causes of toxicity, or most cost-effective controls. For example, in implementing the Ballona Creek TMDL, the Regional Water Board conducted field and laboratory studies with enhanced chemistry analyses and sediment toxicity identification studies for multiple sites. The Regional Water Board found that while chemical contamination and sediment toxicity is present throughout the estuary, TMDL target exceedances showed little relationship to toxicity. Rather, tests showed that pyrethroid pesticides (which were not included as a pollutant of concern in developing the TMDL targets) are the principal cause of the observed sediment toxicity.

Appendix D summarizes the targets, load allocations, and implementation plans for sediment-related TMDLs completed for enclosed bays and estuaries in the state.

2.7.3 Cleanup and Abatement Orders

Regional Water Boards have issued a number of existing cleanup and abatement orders for bays and estuaries to improve sediment quality and reduce toxicity. Under these orders, dischargers or companies are required to cleanup contaminated sediments, soils, or groundwater to background levels, or if background levels are not technologically or economically feasible, to a level determined by the Regional Water Board. For example, the San Diego Regional Water Board is proposing a tentative cleanup order for the contaminated sediments in the San Diego Bay between Sampson Street extension and the mouth of Chollas Creek. The Regional Water Board has proposed a cleanup level that the responsible parties will be required to achieve.

2.7.4 Contaminated Sediment Task Force

In 1997, the governor signed Senate Bill 673 into law, requiring the California Coastal Commission and the Los Angeles Regional Water Board to establish a multi-agency Contaminated Sediments Task Force (CSTF) to assist in the preparation of a long-term management strategy for dredging and disposal of contaminated sediments in the Los Angeles area. The resulting long-term management strategy includes, among other recommendations, a component focused on the reduction of contaminants at their source (CSTF, 2005). The next steps involve implementing the plan. The CSTF Management Committee meets on a quarterly basis to address a number of issues, including continuing refinement of management tools (e.g., BMP toolbox, water quality monitoring, and sediment quality guidelines) (CSTF, 2005).

3. Description of the Amendments

This section describes the applicability of the amendments, and the SQOs, implementation procedures, and monitoring requirements. Also described is the extent of current attainment of the proposed SQOs.

3.1 Applicability

The amendments to the Sediment Quality Plan for Enclosed Bays and Estuaries applies to:

- Enclosed bays[1] and estuaries[2]
- Surficial sediments that have been deposited or emplaced below the intertidal zone, not to sediments characterized by less than 5% fines or substrates composed of gravels, cobbles, or consolidated rock.

The Plan is not applicable to ocean waters including Monterey Bay, Santa Monica Bay, or inland surface waters, and does not govern dredge material suitability determinations or the management of active, designated, or permitted aquatic dredged material disposal or placement sites.

3.2 Sediment Quality Objectives

The SQO to protect wildlife and resident finfish prohibits pollutants in sediment at levels that alone or in combination are toxic to wildlife and resident finfish by direct exposure or bioaccumulate in aquatic life at levels that are harmful to wildlife or resident finfish by indirect exposure. The policy defines wildlife as tetrapod vertebrates, including amphibians, reptiles, birds and mammals, inclusive of marine mammals, and defines resident finfish as any species of bony fish or cartilaginous fish (sharks, skates and rays) whose adult home range occupies all or part of the water body but does not extend into other water bodies.

3.3 Implementation Procedures

The proposed amendments specify that the Water Boards implement the narrative wildlife and resident finfish SQOs on a case-by-case basis, based on an ecological risk assessment. In conducting an ecological risk assessment, the Water Boards shall consider any applicable and relevant ecological risk information including policies and guidance from the following sources:

- California Environmental Protection Agency's (Cal/EPA) Office of Environmental Health Hazard Assessment (OEHHA)
- Cal/EPA's Department of Toxic Substances Control (DTSC)
- California Department of Fish and Game
- U.S. Environmental Protection Agency
- U.S. Army Corps of Engineers
- National Oceanographic Atmospheric Administration
- U.S. Fish and Wildlife Service

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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% of the greatest dimension of the enclosed portion of the bay (SWRCB, 2006a).

[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 are considered estuaries. Estuarine waters generally extend from a bay or the open ocean to the upstream limit of tidal action, but may extend seaward if significant mixing of fresh and salt water occurs in open coastal waters (SWRCB, 2006a).

When threatened or endangered species are present the Water Boards shall consult with these agencies to ensure that these species are adequately protected

3.4 Monitoring and Assessment

The proposed amendments do not include monitoring requirements, although the ecological risk assessment specified in the implementation procedures involves monitoring. For example, DTSC's ERA guidance (CA EPA, 1996) indicates that an ERA should include the following steps:

- Scoping assessment – includes site characterization (e.g., trophic level structure, food web transfer of contaminants), biological characterization (e.g., identification of distinct habitats, identification of species and communities present, identification of species indicative of normal functioning ecosystem, identification of common site receptors), and pathway assessment (e.g., identify potential for contact between receptors and chemicals of concern)
- Predictive assessment – involves selection of representative species and toxicity data, identification of measurement endpoints, evaluation of potential exposure pathways and contact rates, and calculation of hazard quotients and a hazard index.
- Validation study – refine and validate parameters used to estimate the risk to exposed biota through sampling and analysis, or validate conclusions of predictive assessment through site-specific laboratory and/or field testing
- Impact assessment – conduct field testing and/or more extensive laboratory testing to assess the severity and extent of population and community effects as input to the evaluation of remedial alternatives and refinement of remediation goals.

The goal of the ecological risk assessment is to predict potential adverse effects and when appropriate, to measure existing adverse effects, of chemical contaminants on the biota on or near a site or facility, and to determine levels of those chemicals in the environment that would not be expected to adversely affect the biota.

3.5 Attainment

As discussed in Section 2, there are currently 127 segments of bays and estuaries on the State's 2010 303(d) list for toxic pollutants, including 88 listings for sediment quality, and 48 sites identified as known toxic hot spots under the State Water Board's BPTCP. In addition, the State Water Board (2008) identified an additional 8 bays that may be impaired based on the direct effects benthic community SQO. The extent to which those impairments result in direct or indirect toxicity to wildlife and finfish represents the level of existing nonattainment of the proposed wildlife and finfish SQO.

The proposed Plan amendments could also result in additional efforts to assess attainment of fish and wildlife beneficial uses in bays and estuaries, which in turn could result in identification of new impairments or changes to existing impairments. **Exhibit 3-1** indicates the possible outcomes under the proposed Plan amendments.

Exhibit 3-1. Potential Incremental Impacts Associated with the Proposed Plan Amendments

Assessment of Attainment of Existing Beneficial Uses	Assessment Under Proposed SQO: Impairment not attributable to sediments	Assessment Under Proposed SQO: Impairment attributable to sediments
Impairment not attributable to sediments	• No change in sediment quality. • Potential incremental assessment costs.	• Sediment quality improvement. • Potential incremental assessment and control costs.
Impairment attributable to sediments	• Sediment quality remains the same, which may be lower than under implementation of baseline narrative objective. • Potential incremental assessment costs, but will avoid unnecessary control costs.	• Change in sediment quality if better data lead to change in control strategies. • Potential incremental assessment costs; potential incremental costs or cost-savings depending on differences in control strategies.

4. Methods of Compliance and Potential Costs

This section identifies potential means of compliance with the Plan, and the potential costs of those measures.

4.1 Monitoring and Assessment

As discussed in Section 2, there are extensive monitoring and assessment activities supporting the baseline regulatory framework. Absent the proposed Plan amendments, these activities will continue, and additional efforts will be undertaken (e.g., as Regional Boards assess compliance with existing objectives for sediment toxicity, and address sites currently impaired for sediment toxicity). That is, data is needed to determine whether sediments are in compliance with existing narrative objectives for sediment toxicity related to fish and wildlife. Similarly, in instances in which sediments exceed baseline objectives for sediment toxicity, assessment of the causes and sources will be needed in order to identify means of compliance with the objectives. These activities, which can include developing a work plan/project management, collecting additional data, conducting ERAs or toxicity identification evaluations (TIEs), surface water modeling, and other analysis, may be conducted as part of developing a TMDL (SCCWRP, 2005; Parsons, et al., 2002, as cited in WSPA, 2007).

The objective of ERA is to evaluate the potential for biological effects to occur as a result of exposure to one or more stressors in the environment. ERA is a flexible iterative process that can be used for any site segment or waterbody either prospectively to assess future conditions or retrospectively to assess risk associated with spills or releases or existing degradation (U.S. EPA, 1998). ERAs may be relatively simple or extremely complex depending upon the site conditions, number of pollutants, exposure pathways and receptors. In all cases, a variety of expertise is needed to ensure that the results of the ERA are relevant for the species exposure pathways and pollutants associated with the site segment or waterbody.

SWRCB (2008) provided unit costs for monitoring to assess the SQOs to protect the benthic community (direct effects). Monitoring efforts for ERAs to assess indirect effects to wildlife and finfish beyond the monitoring necessary to assess water quality criteria and the SQOs for direct effects could involve collecting finfish and documenting the presence of deformities, irregularities in size, or population effects, and collection and analysis of wildlife tissue or bird eggs. **Exhibit 4-1** provides unit costs for these types of analyses. Sample collection costs may vary based on factors such as water depth, abundance of fish species, sediment characteristics (may cause unsuccessful grabs that need to be repeated), and distance between stations. Although data for some parameters may not be needed at each sampling site, the total costs per sampling event could be in the range of $7,400 to $11,700.

Exhibit 4-1. Incremental Sampling Costs to Assess Finfish and Wildlife Health[1]

Parameter	Unit Cost	Number per Event	Total Cost
Fish Collection (for sampling or observation)[2]	$1,500 – $1,800 per site	1	$1,500 – $1,800
Metals suite (tissue)	$175 – $225 per sample	6*	$1,050 – $1,350
Mercury (tissue)	$30 – $80 per sample	6*	$180 – $480
Chlorinated pesticides (tissue)	$200 – $575 per sample	6*	$1,200 – $3,450
PCBs suite (tissue)	$575 – $775 per sample	6*	$3,450 – $4,650
Total cost per sampling event	NA	NA	$7,380 – $11,730

Source: SCCWRP (2011) and SWRCB (2011a).
*Three fish per species and two species per site.
1. Incremental to sampling requirements to assess attainment of SQOs for direct effects in bays and estuaries. See SWRCB (2008)
2. Includes boat, materials, and labor for observing fish communities or collecting fish for sampling.

To assess attainment of the proposed SQO, the number of stations from which data should be collected will vary based on water body-specific factors including:

- area
- tidal flow and/or direction of predominant currents
- historic and or legacy conditions in the vicinity of the water body
- 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 of the water body.

Exhibit 4-2 shows the minimum number of samples for different size bays, assuming that sediment conditions are relatively homogeneous. These estimates reflect a goal of providing a spatially-based measure of fish and wildlife health with a level of precision similar to that used in regional monitoring programs throughout California. Different numbers of stations may be required for targeted or focused studies.

Exhibit 4-2. Potential Number of Samples to Assess Compliance

Bay Size (acres)	Number of Sites
<500	5
500-5000	12
>5000	30

Source: SCCWRP (2007).

The State Water Board estimates that there are approximately 7 bays and estuaries with areas greater than 5,000 acres, 10 with areas between 500 and 5,000 acres, and 84 with areas less than 500 acres for which monitoring to assess compliance with the proposed SQO could be necessary. Assuming that assessments of fish and wildlife health would be based on the number of sites per water body in Exhibit 4-2, incremental monitoring costs could range from approximately $5.5 million to $8.8 million.

For bays and estuaries not currently on the 303(d) list for sediment toxicity that would exceed the SQO under the proposed Plan amendments, the next step under the Plan would be a sequential approach to manage the sediment appropriately, including developing and implementing a work plan to confirm and characterize pollutant-related impacts, identify pollutants, and identify sources and management actions (including adopting a TMDL, if appropriate). The cost of this sequential approach will vary depending on a number of factors, including the extent of baseline efforts and studies underway to address other impairment issues, and the number of potential stressors to the area. Note that in the absence of the Plan amendments, Regional Water Boards could identify these waters as exceeding the narrative objectives, and thus incremental impacts associated with TMDL development and pollution controls would be zero.

The State Water Board (2001) estimates that development of complex TMDLs (including an implementation plan) may cost over $1 million. In addition, SWRCB (2003a) indicates that TMDL development and mercury reduction strategy cost for the San Francisco Bay could range from $10 million to $20 million. These estimates provide some indication of costs that can be associated with sequential approaches to managing designated use impairments. Thus, the estimates provides an approximation of the potential magnitude of both costs (incremental listings) and cost savings (changes in listings due to additional information to accurately identify the cause of the impairment) that may be associated with changes in the identification of impairments under the baseline objectives and the proposed Plan amendments.

4.2 Potential Controls

For waters that Regional Water Boards identify as being impaired based on the wildlife and finfish SQO under the Plan, remediation actions and/or source controls will be needed to bring them into compliance. Many bays and estuaries are already listed for sediment impairments or are exceeding the benthic community or human health SQOs and, therefore, would require controls under baseline conditions. When the baseline controls are identical to the ones that would be implemented for the wildlife and finfish SQO, there is no incremental cost or cost savings associated with the Plan amendments. When the baseline controls differ, there is potential for either incremental costs or cost-savings associated with the Plan amendments.

For an increased in pollution controls cost associated with nonattainment of the wildlife and finfish SQO, the concentration of toxic pollutants in discharges would have to meet levels that are more stringent than what is needed to achieve compliance with existing objectives (e.g., since they could have to control based on the benthic community and human health SQOs, narrative sediment objectives, or the CTR). Incremental costs for controls may also result from the identification of additional chemical stressors that are not included in the CTR or Basin Plans. For example, in Ballona Creek, the Regional Water Board identified pyrethoid pesticides as the cause of sediment toxicity, and not metals and other toxic pollutants for which CTR criteria and sediment TMDL targets that already existed (City of Los Angeles WPD, 2010). Since many practices that may be employed under existing TMDLs are applicable for controlling the mobilization of pollutants in general, this situation is also difficult to estimate. For example, the TMDL for pesticides and PCBs in the Calleguas Creek watershed indicates that the BMPs needed to achieve the nutrient and toxicity TMDLs for the watershed would likely reduce pesticides and PCBs to necessary levels as well (LARWQCB, 2005c).

Thus, without being able to identify the particular pollutants causing toxicity to wildlife and finfish, and the development of discharge concentrations needed to achieve the objectives, the needed controls to achieve those concentrations are difficult to estimate. The following sections discuss these issues; Appendix F provides additional information on unit costs.

4.2.1 Municipal and Industrial Facilities

Regional Water Boards regulate municipal and industrial wastewater treatment facilities through the NPDES permit program. If these dischargers have potential to cause or contribute to an exceedance of water quality standards contained in Phase I of the Plan, Basin Plans (narrative and numeric), the CTR, or any other applicable policy, permit writers assign effluent limits. Regional Water Boards may also adopt more stringent criteria for specific pollutants where necessary (e.g., to meet a TMDL, site-specific objectives). If the Plan requires municipal and industrial dischargers to reduce pollutant concentrations to levels below those required by existing standards, it is likely that these facilities would implement source control to eliminate the pollutant from entering their treatment plant or industrial process, or pursue regulatory relief (e.g., a variance), rather than install costly end-of-pipe treatment. However, it is uncertain whether such a situation would arise as a result of the Plan amendments.

4.2.2 Agriculture

Regional Water Boards regulate farmers primarily through the conditional WDR waivers that require compliance with water quality standards. Regional Water Boards may also require farmers to meet more stringent criteria for specific pollutants where necessary (e.g., to meet a TMDL, site-specific objectives). All of the affected Regional Water Boards have narrative objectives that specifically prohibit the discharge of pesticides and/or toxic pollutants that cause detrimental effects in aquatic life or to animals and humans. Thus, even in the absence of the Plan amendments, farmers would be prohibited from causing or contributing to toxicity to wildlife and finfish.

4.2.3 Storm Water

An incremental level of control for storm water sources (e.g., need to implement new practices, increase the frequency of existing practices, or install structural controls that might not be required under existing objectives) may or may not be necessary for compliance with the Plan amendments. For any situation in which storm water sources are specifically required to control toxic pollutants to levels that are lower than what would be necessary in the absence of the Plan amendments, potential means of compliance include:

- Increased or additional nonstructural BMPs – institutional, education, or pollution prevention practices designed to limit generation of runoff or reduce the pollutants load of runoff
- Structural controls – engineered and constructed systems designed to provide water quantity or quality control.

The following sections provide general discussion of the types of activities and associated costs that may be affected by changes in control strategies attributable to the Plan.

Nonstructural BMPs

Nonstructural BMPs can be very effective in controlling pollution generation at the source, which in turn can reduce or eliminate the need for costly end-of-pipe treatment or structural controls. Most municipal SWMPs primarily implement nonstructural BMPs to meet existing permit requirements. It is possible that additional or increased efforts for certain nonstructural BMPs could be used for compliance with the Plan. Examples include expanding an existing outreach and education program to a larger or new target audience, refocusing source control efforts on pollutants and sources of concern (e.g., pesticide/herbicide use or integrated pest management program), increasing program compliance efforts, and increasing frequency, duration, or efficiency of maintenance practices such as street sweeping.

Although nonstructural practices play an invaluable role in protecting surface water, costs and effectiveness are not easily quantified, primarily because there are no design standards for these practices (SWRCB, 2006c) and because many have been education-oriented with high up-front costs to develop outreach materials. For example, the State Water Board's Erase the Waste campaign is a public education program that works to reduce storm water pollution and improve the environment of coastal and inland communities. The State Water Board launched the campaign in Los Angeles County in August 2003 as a 2-year, $5 million outreach campaign (SWRCB, 2004c). However, the materials produced are now available statewide (SWRCB, 2006c). Thus, expanding the program to other regions would not be as costly as starting a similar program from scratch.

A recent survey of California municipalities reports a mean annual cost of $26 per household for nonstructural SWMP measures including: public education and outreach, illicit discharge detection and elimination, construction site storm water runoff control, post construction storm water management in new development and redevelopment, and pollution prevention and good housekeeping for municipal operations such as street sweeping (CSU Sacramento, 2005). Incremental costs to improve the effectiveness of these measures may have a similar order of magnitude, although actual costs will vary depending on the baseline program, the incremental activities, municipality size, and degree of coordination with other municipalities. Appendix F provides additional examples of nonstructural BMP cost estimates.

Structural Controls

There are a variety of structural means to control the quantity and quality of storm water runoff including infiltration systems, detention systems, retention systems, constructed wetlands, filtration systems, and vegetated systems. The cost for any particular structure depends on the type of control, the quantity of water treated, and site-specific factors such as land cost. Incremental costs or cost-savings associated with the Plan amendments cannot be estimated without information on differences, if any, in structural control strategies between baseline and Plan conditions. Appendix F provides examples of cost estimates for individual structures.

4.2.4 Marinas and Boating Activities

Control measures that address toxic pollutants from marinas and boating activities include:

- Use of biocide-free paint on boats or more frequent boat hull cleaning to prevent leaching of toxic paints
- Performing above waterline boat maintenance activities in a lined channel to prevent debris from entering the water
- Performing below waterline boat maintenance on land in area with runoff (and dust) controls
- Developing a collection system for toxic materials at harbors.

Although water quality controls for marinas are less common than controls for urban storm water, information on TMDL and toxic hotspot cleanups indicates that they may be included in baseline strategies for impaired sites. However, there may also be incremental costs or cost savings at these sites as a result of the Plan amendments. Sites that are not exceeding current objectives, but would be exceeding the wildlife and finfish SQO could incur incremental control costs if boating activities contribute to sediment toxicity that harms fish and wildlife. Conversely, there may be cost savings for sites exceeding current standards that are not exceeding the proposed SQO.

Incremental costs or cost savings will depend on the pollutants of concern, the types of activities undertaken, and in some cases the number of boats affected. Appendix F provides examples of the types of activities that may be included in incremental costs (or cost savings if baseline activities are not necessary).

4.2.5 Wetlands

Incremental wetland controls may or may not be necessary to achieve compliance with the proposed SQO. Potential means of compliance include: aeration, channelization, revegetation, sediment removal, levees, or a combination of these practices.

For methylmercury and selenium in particular, protection of wildlife may result in the need for incremental controls in certain water bodies to reduce pollutants to levels that would be necessary in the absence of the Plan amendments (e.g., protection of human health only). However, the location and extent of controls needed and the types of controls are unknown. One example of efforts underway elsewhere is the Anderson Marsh wetland on Cache Creek. This wetland is located within a 1,000-acre park that also includes oak woodlands and riparian areas. Various management practices mentioned above may be applied upstream to reduce inorganic mercury in water flowing into the wetland, thus reducing methylmercury formation, and other practices may reduce the downstream transport of methylmercury formed in the wetland. The Central Valley Regional Water Board (2005b) provides capital cost estimates for controlling methylmercury export from Anderson March ranging from $200,000 to $1 million, and O&M costs ranging from $20,000 to $100,000 per year.

4.2.6 Cleanup and Remediation Activities

There is uncertainty as to whether incremental cleanup and remediation activities will be required as a result of the Plan amendments. In addition, based on the implementation plans for existing TMDLs, Regional Water Boards are likely to pursue source controls for ongoing sources and only require remediation activities for historical pollutants with no known, ongoing sources. However, for any situation in which cleanup or remediation would be required that would not be conducted in the absence of the Plan amendments, costs will depend on the technical feasibility of different strategies (e.g., capping, removal and disposal, removal and treatment and disposal), the proximity of source material (for capping) or to appropriate treatment and disposal facilities, whether disposal facilities exist or whether new facilities must be built, as well as other factors. Costs for any sediment remediation actions necessary as a result of the Plan could be similar to those estimated by the Regional Water Board for hot spot cleanup shown in Exhibit 2-5. Appendix F provides additional discussion regarding potential costs.

5. Analysis of Statewide Costs

This section provides a summary of the economic considerations of the Plan amendments, and discusses the key sources of uncertainty in the analysis.

5.1 Sediment Quality and Costs in the Absence of the Plan

There are currently 127 segments of bays and estuaries on the State's 2010 303(d) list for toxic pollutants, including 88 listings for sediment quality, and 48 sites identified as known toxic hot spots under the State Water Board's BPTCP. In addition, the State Water Board (2008) identified an additional 8 bays that may be impaired based on the direct effects benthic community SQO. These conditions require substantial resources to be spent over the next decades for monitoring, assessment, TMDL development, pollution controls, and sediment cleanup and remediation. These resources include an estimated $87.6 million to $1.03 billion for cleanup and remediation of toxic hot spots that are of high priority (SWRCB, 2003b).

All Regional Water Boards currently have narrative objectives for toxic substances, toxicity, pesticides, bioaccumulation, or a combination of these categories. Although these narrative objectives are subject to interpretation and are implemented according to each Regional Water Board's policy, any water body could potentially be listed because of detrimental physiological responses in animals or aquatic life, bioaccumulation in biota or fish resulting in adverse effects to aquatic life and wildlife, sediment toxicity, or high concentrations of toxic substances (especially pesticides) in sediments. There is uncertainty regarding whether the TMDLs developed or under development for listed waters would result in restoring beneficial uses. Indeed, TMDLs are often phased, such that evaluation of early actions can result in changes or redirection of future actions. Thus, additional costs could be incurred in the future in order to eliminate sediment toxicity to wildlife and finfish in bays and estuaries.

5.2 Sediment Quality and Costs under the Plan

As shown in Section 4.1, incremental costs associated with monitoring and assessment of the wildlife and finfish SQO could be as much as $5.5 million to $8.8 million. Where assessment indicates that the proposed SQO is not being attained, there could be additional costs associated with more comprehensive ERAs and TMDL development and implementation and remedial actions.

Note, however, that these actions could also occur in the absence of the Plan based on existing monitoring and assessment practices. For example, Anchor Environmental (2006) performed an ERA for the Rhine Channel sediment remediation feasibility study. The Rhine Channel is a toxic hotspot under the Water Boards Bay Protection Program and on the 303(d) list for copper, pesticides, chlordane, DDT, PCBs, and sediment toxicity in lower Newport Bay. The ERA focused on risks associated with bioaccumulation and trophic transfer from sediment into fish and wildlife (including benthic and pelagic forage fish and higher trophic level species including California halibut, harbor seal, and brown pelican) for copper, mercury, selenium, DDE and PCBs. The purpose of the ERA was to assess and characterize existing risks to aquatic life and biota associated with contaminants in sediment. Anchor Environmental (2006) used the results to evaluate potential management actions. Thus, incremental costs associated with the proposed Plan amendments are highly uncertain.

5.3 Uncertainties

Data limitations prevent estimating incremental control costs or cost savings associated with the proposed Plan amendments. In addition, there is also uncertainty regarding baseline conditions that may affect the evaluation of the incremental economic impacts of the narrative SQOs. For example, existing TMDLs and hot spot cleanup and remediation actions have yet to be implemented, and the sediment quality that would result without the Plan is unknown. Baseline control scenarios are relevant because many practices can reduce loadings for a wide variety of pollutants. For example, the TMDL for pesticides and PCBs in the Calleguas Creek watershed indicates that the BMPs needed to achieve the nutrient and toxicity TMDLs for the watershed would likely reduce pesticides and PCBs to necessary levels as well (LARWQCB, 2005c). Thus, controls to address existing impairments (for water or sediment) could alter the assessment of compliance with the objectives.

6. References

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Appendix A. Current Narrative Objectives Applicable to Sediment Quality

This Appendix lists the current narrative Regional Water Board Basin Plan objectives that relate to sediment quality.

North Coast Regional Water Board (Region 1)

- Toxicity – All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, bioassays of appropriate duration, or other appropriate methods as specified by the Regional Water Board.
- Pesticides – No individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses. There shall be no bioaccumulation of pesticide concentrations found in bottom sediments or aquatic life.

San Francisco Bay Regional Water Board (Region 2)

- Bioaccumulation – Many pollutants can accumulate on particles, in sediment, or bioaccumulate in fish and other aquatic organisms. Controllable water quality factors shall not cause a detrimental increase in concentrations of toxic substances found in bottom sediments or aquatic life. Effects on aquatic organisms, wildlife, and human health will be considered.
- Toxicity – All waters shall be maintained free of toxic substances in concentrations that are lethal to or that produce other detrimental responses in aquatic organisms. Detrimental responses include, but are not limited to, decreased growth rate and decreased reproductive success of resident or indicator species. There shall be no acute toxicity in ambient waters. There shall be no chronic toxicity in ambient waters.
- The health and life history characteristics of aquatic organisms in waters affected by controllable water quality factors shall not differ significantly from those for the same waters in areas unaffected by controllable water quality factors.

Central Coast Regional Water Board (Region 3)

- Toxicity – All waters shall be maintained free of toxic substances in concentrations which are toxic to, or which produce detrimental physiological responses in, human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, toxicity bioassays of appropriate duration, or other appropriate methods as specified by the Regional Water Board.
- Pesticides – No individual pesticide or combination of pesticides shall reach concentrations that adversely affect beneficial uses. There shall be no increase in pesticide concentrations found in bottom sediments or aquatic life.

Los Angeles Regional Water Board (Region 4)

- Pesticides – No individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses. There shall be no increase in pesticide concentrations found in bottom sediments or aquatic life.
- Bioaccumulation – Toxic pollutants shall not be present at levels that will bioaccumulate in aquatic life to levels which are harmful to aquatic life or human health.

- Toxicity – All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, bioassays of appropriate duration, or other appropriate methods as specified by the Regional Water Board.

Central Valley Regional Water Board (Region 5)

- No individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses; discharges shall not result in pesticide concentrations in bottom sediments or aquatic life that adversely affect beneficial uses; total identifiable persistent chlorinated hydrocarbon pesticides shall not be present in the water column at concentrations detectable within the accuracy of analytical methods approved by EPA or the Executive Officer; and pesticide concentrations shall not exceed the lowest levels technically and economically achievable.
- All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life. This objective applies regardless of whether the toxicity is caused by a single substance or the interactive effect of multiple substances. Compliance with this objective will be determined by analyses of indicator organisms, species diversity, population density, growth anomalies, and biotoxicity tests of appropriate duration or other methods as specified by the Regional Water Board.

Santa Ana Regional Water Board (Region 8)

- Toxic Substances – Toxic substances shall not be discharged at levels that will bioaccumulate in aquatic resources to levels which are harmful to human health. The concentrations of toxic substances in the water column, sediments or biota shall not adversely affect beneficial uses.

San Diego Regional Water Board (Region 9)

- Pesticides – No individual pesticide or combination of pesticides shall be present in the water column, sediments or biota at concentrations that adversely affect beneficial uses. Pesticides shall not be present at levels which will bioaccumulate in aquatic organisms to levels which are harmful to human health, wildlife, or aquatic organisms.
- Toxicity – All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, bioassays of appropriate duration, or other appropriate methods as specified by the Regional Water Board.

Appendix B. Current Water Quality Objectives

This Appendix lists the current water quality objectives for toxic pollutants under the California Toxics Rule (CTR).

Exhibit B-1. CTR Priority Toxic Pollutant Criteria (concentrations in µg/L)

Pollutant	Freshwater		Saltwater		Human Health For consumption of:	
	Acute	Chronic	Acute	Chronic	Water & Organisms	Organisms Only
Antimony					14	4300
Arsenic	340	150	69	36		
Beryllium						
Cadmium [2]	4.3	2.2	42	9.3		
Chromium (III)	550	180				
Chromium (VI)	16	11	1100	50		
Copper	13	139.0	4.8	3.1	1300	
Lead	65	652.5	210	8.1		
Mercury					0.05	0.051
Nickel	470	47052	74	8.2	610	4600
Selenium		5.0	290	71		
Silver	3.4	3.4	1.9			
Thallium					1.7	6.3
Zinc [2]	120	120	90	81		
Cyanide	22	5.2	1	1	700	220,000
Asbestos					7,000,000 fibers/L	
2,3,7,8-TCDD (dioxin)					0.000000013	0.000000014
Acrolein					320	780
Acrylonitrile					0.059	0.66
Benzene					1.2	71
Bromoform					4.3	360
Carbon Tetrachloride					0.25	4.4
Chlorobenzene					680	21,000
Chlorodibromomethane					0.401	34
Chloroethane						
2-Chloroethylvinyl Ether						
Chloroform						
Dichlorobromomethane					0.56	46
1,1-Dichloroethane						
1,2-Dichloroethane					0.38	99
1,1-Dichloroethylene					0.057	3.2
1,2-Dichloropropane					0.52	39
1,3-Dichloropropylene					10	1,700
Ethylbenzene					3,100	29,000
Methyl Bromide					48	4,000
Methyl Chloride						
Methylene Chloride					4.7	1,600
1,1,2,2-Tetrachlorethane					0.17	11
Tetrachloroethylene					0.8	8.85
Toluene					6,800	200,000

Exhibit B-1. CTR Priority Toxic Pollutant Criteria (concentrations in µg/L)

Pollutant	Freshwater		Saltwater		Human Health For consumption of:	
	Acute	Chronic	Acute	Chronic	Water & Organisms	Organisms Only
1,2-Trans-Dichloroethylene					700	140,000
1,1,1-Trichloroethane						
1,1,2-Trichloroethane					0.60	42
Trichloroethylene					2.7	81
Vinyl Chloride					2	525
2-Chlorophenol					120	400
2,4-Dichlorophenol					93	790
2,4-Dimehtylphenol					540	2,300
2-Methyl-4,6-Dinitrophenol					13.4	765
2,4-Dinitrophenol					70	14,000
2-Nitrophenol						
4-Nirtophenol						
3-Methyl-4-Chlorophenol						
Pentachlorophenol					0.28	8.2
Phenol					21,000	4,600,000
2,4,6-Trichlorophenol					2.1	6.5
Acenaphthene					1,200	2,700
Acenaphthylene						
Anthracene					9,600	110,000
Benzidine					0.00012	0.00054
Benzo(a)Anthracene					0.0044	0.049
Benzo(a)Pyrene					0.0044	0.049
Benzo(b)Fluoranthene					0.0044	0.049
Benzo(ghi)Perylene						
Benzo(k)Fluoranthene					0.0044	0.049
Bis(2-Chloroethoxy)Methane						
Bis(2-Chloroethyl)Ether					0.031	1.4
Bis(2-Chloroisopropyl)Ether					1,400	170,000
Bis(2-Ethylhexyl)Phthalate					1.8	5.9
4-Bromophenyl Phenyl Ether						
Butylbenzyl Phthalate					3,000	5,200
2-Chloronaphthalene					1,700	4,300
4-Chlorophenyl Phenyl Ether						
Chrysene					0.0044	0.049
Dibenzo(a,h)Anthracene					0.0044	0.049
1,2 Dichlorobenzene					2,700	17,000
1,3 Dichlorobenzene					400	2,600
1,4 Dichlorobenzene					400	2,600
3,3'-Dichlorobenzidine					0.04	0.077
Diethyl Phthalate					23,000	120,000
Dimethyl Phthalate					313,000	2,900,000
Di-n-Butyl Phthalate					2,700	12,000
2,4-Dinitrotoluene					0.11	9.1
2,6- Dinitrotoluene						
Di-n-Octyl Phthalate						
1,2-Diphenylhydrazine					0.040	0.54

Exhibit B-1. CTR Priority Toxic Pollutant Criteria (concentrations in μg/L)

Pollutant	Freshwater		Saltwater		Human Health For consumption of:	
	Acute	Chronic	Acute	Chronic	Water & Organisms	Organisms Only
Fluoroanthene					300	370
Fluorene					1,300	14,000
Hexachlorobenzene					0.00075	0.00077
Hexachlorobutadiene					0.44	50
Hexachlorocyclopentadiene					240	17,000
Hexachloroethane					1.9	8.9
Indeno(1,2,3-cd) Pyrene					0.0044	0.049
Isophorone					8.4	600
Naphthalene						
Nitrobenzene					17	1,900
N-Nitrosodimethylamine					0.00069	8.1
N-Nitrosodi-n-Propylamine					0.005	1.4
N-Nitrosodiphenylamine					5.0	16
Phenanthrene						
Pyrene					960	11,000
1,2,4-Trichlorobenzene						
Aldrin	3		1.3		0.00013	0.00014
Alpha-BHC					0.0039	0.013
Beta-BHC					0.014	0.046
Gamma-BHC	0.95		0.16		0.019	0.063
Delta-BHC	2.4					
Chlordane [1]	1.1	0.0043	0.09	0.004	0.00057	0.00059
4,4'-DDT		0.001	0.13	0.001	0.00059	0.00059
4,4'-DDE					0.00059	0.00059
4,4'-DDD	0.24				0.00083	0.00084
Dieldrin	0.22	0.056	0.71	0.0019	0.00014	0.00014
Alpha-Endosulfan	0.22	0.056	0.034	0.0087	110	240
Beta-Endosulfan		0.056	0.034	0.0087	110	240
Endosulfan Sulfate					110	240
Endrin	0.086	0.036	0.037	0.0023	0.76	0.81
Endrin Aldehyde	0.52				0.76	0.81
Heptachlor	0.52	0.0038	0.053	0.0036	0.00021	0.00021
Heptachlor Epoxide		0.0038	0.053	0.0036	0.00010	0.00011
Polychlorinated biphenyls (PCBs)	0.73	0.014		0.03	0.00017	0.00017
Toxaphene		0.0002	0.21	0.0002	0.00073	0.00075

1. Regions 1, 4, and 9 have municipal water supply use maximum contaminant level criterion for chlordane = 0.1 μg/L.
2. The maximum dissolved cadmium criterion for the Sacramento River and its tributaries above State Hwy 32 Bridge at Hamilton City in Region 5 is 0.22 μg/L; the maximum dissolved zinc criterion for Sacramento River from Keswick Dam to the I Street Bridge at City of Sacramento; American River from Folsom Dam to the Sacramento River; Folsom Lake (50); and the Sacramento-San Joaquin Delta is 0.1 mg/L.
3. Region 2 has aquatic life criteria for mercury: saltwater 4-day average = 0.025 μg/L; saltwater 1-hr average = 2.1 μg/L; freshwater 4-day average = 0.025 μg/L; freshwater 1-hr average = 2.4 μg/L. Region 3 has aquatic life criteria for mercury: freshwater average = 0.05 μg/L; freshwater maximum = 0.2 μg/L; marine habitats average = 0.05 μg/L; marine habitats maximum = 0.1 μg/L.

Appendix C. Nonpoint Source Plan Management Measures

This appendix provides a description of the management measures (MMs) applicable to sediment toxicity control from California's Nonpoint Source Management Program Plan.

There are five MMs in the NPS Program Plan relevant to sediment toxicity control for agriculture (**Exhibit C-1**).

Exhibit C-1. Agricultural Management Measures

MM Code	Agriculture MM Title	Description
1A	Erosion and Sediment Control	Where erosion and sedimentation from agricultural lands affects coastal waters and/or water bodies listed as impaired by sediment, landowners must design and install or apply a combination of practices to reduce solids and associated pollutants in runoff during all but the larger storms. Alternatively, landowners may apply the erosion component of a Resource Management System as defined in the U.S. Department of Agriculture Natural Resources Conservation Service Field Office Technical Guide.
1D	Pesticide Management	Implementation will occur through cooperation with the Department of Pesticide Regulation by development and adoption of reduced risk management strategies (including reductions in pesticide use); evaluation of pest, crop, and field factors; use of Integrated Pest Management (IPM); consideration of environmental impacts in choice of pesticides; calibration of equipment; and use of anti-backflow devices. IPM strategies are key and include evaluating pest problems in relation to cropping history and previous pest control measures, and applying pesticides only when an economic benefit will be achieved. Pesticides should be selected based on their effectiveness to control target pests and environmental impacts such as their persistence, toxicity, and leaching potential.
1F	Irrigation Water Management	Irrigation water would be applied uniformly based on an accurate measurement of crop water needs and the volume of irrigation water applied, considering limitations raised by such issues as water rights, pollutant concentrations, water delivery restrictions, salt control, wetland, water supply, and frost/freeze temperature management. Additional precautions would apply when chemicals are applied through irrigation.
1G	Education/Outreach	Implement pollution prevention and education programs such as: activities that cause erosion and loss of sediment on agricultural land; activities that cause discharge from confined animal facilities (excluding Concentrated Animal Feeding Operations) to surface water; activities that cause excess delivery of nutrients and/or leaching of nutrients; activities that cause contamination of surface water and ground water from pesticides; grazing activities that cause physical disturbance to sensitive areas and the discharge of sediment, animal waste, nutrients, and chemicals to surface and ground waters; irrigation activities that cause nonpoint source pollution of surface waters.

Source: SWRCB (2000).

There are 11 MMs that address the various forestry operations and practices (**Exhibit C-2**). The Forest Practice Rules (FPRs) also closely reflect these silvicultural MMs.

Exhibit C-2. Forestry Management Measures

MM Code	Code Forestry MM Title	Description
2A	Pre-Harvest Planning	Silvicultural activities should be planned to reduce potential delivery of pollutants to surface waters by addressing the timing, location, and design of harvesting and road construction; site preparation; identification of sensitive or high-erosion risk areas; and the potential for cumulative water quality impacts.
2B	Streamside Management Areas (SMAs)	Protect against soil disturbance and reduce sediment and nutrient delivery to waters from upland activities. Intended to safeguard vegetated buffer areas along surface waters to protect the water quality of adjacent streams.
2C	Road construction/Reconstruction	Road construction/reconstruction should be conducted so as to reduce sediment generation and delivery by following preharvest plan layouts and designs for road systems, incorporating adequate drainage structures, properly installing stream crossings, avoiding road construction in SMAs, removing debris from streams, and stabilizing areas of disturbed soil such as road fills.
2D	Road Management	Management of roads to prevent sedimentation, minimize erosion, maintain stability, and reduce the risk that drainage structures and stream crossings will fail or become less effective. Implementation includes inspections and maintenance actions to prevent erosion of road surfaces and to ensure the effectiveness of stream-crossing structures. Also address appropriate methods for closing roads that are no longer in use.
2E	Timber Harvesting	Addresses skid trail location and drainage, management of debris and petroleum, and proper harvesting in SMAs. Timber harvesting practices that protect water quality and soil productivity also have economic benefits by reducing the length of roads and skid trails, reducing equipment and road maintenance costs, and providing better road protection.
2F	Site Preparation and Forest Regeneration	Impacts of mechanical site preparation and regeneration operations—particularly in areas that have steep slopes or highly erodible soils, or where the site is located in close proximity to a water body—can be reduced by confining runoff onsite. This measure addresses keeping slash material out of drainage ways, operating machinery on contours, timing of activities, and protecting ground cover in ephemeral drainage areas and SMAs. Careful regeneration of harvested forestlands is important in protecting water quality from disturbed soils.
2H	Revegetation of Disturbed Areas	Addresses the rapid revegetation of areas disturbed during timber harvesting and road construction—particularly areas within harvest units or road systems where mineral soil is exposed or agitated (e.g., road cuts, fill slopes, landing surfaces, cable corridors, or skid trails) with special priority for SMAs and steep slopes near drainage ways.
2I	Forest Chemical Management	Application of pesticides, fertilizers, and other chemicals used in forest management should not lead to surface water contamination. Pesticides must be properly mixed, transported, loaded, and applied, and their containers disposed of properly. Fertilizers must also be properly handled and applied since they also may be toxic depending on concentration and exposure. Includes applications by skilled workers according to label instructions, careful prescription of the type and amount of chemical to be applied, use of buffer areas for surface waters to prevent direct application or deposition, and spill contingency planning.
2J	Wetlands Forest Management	Forested wetlands provide many beneficial water quality functions and provide habitat for aquatic life. Activities in wetland forests should be conducted to protect the aquatic functions of forested wetlands.

Exhibit C-2. Forestry Management Measures

MM Code	Code Forestry MM Title	Description
2K	Postharvest Evaluation	Incorporate postharvest monitoring, including (a) implementation monitoring to determine whether the operation was conducted according to specifications, and (b) effectiveness monitoring after at least one winter period to determine whether the specified operation prevented or minimized discharges.
2L	Education/Outreach	Implement pollution prevention and education programs to reduce NPS pollutants generated by applicable silvicultural activities.

Source: SWRCB (2000).

California's 15 urban MMs (**Exhibit C-3**) are organized to parallel the land use development process to address the prevention and treatment of pollution during all phases of urbanization; this strategy relies primarily on pollution prevention or source reduction practices.

Exhibit C-3. Urban Management Measures

MM Code	Urban MM Title	Description
3.1A	Developing Areas – Watershed Protection	Encourage land use and development planning on a watershed scale that takes into consideration sensitive areas that, by being protected, will maintain or improve water quality.
3.1B	Developing Areas – Site Development	Aims to protect areas that provide important water quality benefits and limit land disturbance.
3.1C	Developing Areas – New Development	Addresses increased pollutant loads associated with developed lands, and the hydrologic alterations resulting from development that affects runoff volume and timing. Developers can use innovative site planning techniques or incorporate runoff management practices to reduce the hydrologic impact of development on receiving waters.
3.2A	Construction Sites – Construction Site Erosion and Sediment Control	Aims to reduce erosion through implementation of erosion and sediment control practices.
3.2B	Construction Sites – Chemical Control	Implement a chemical control plan to: limit application, generation, and migration of toxic substances; ensure proper storage and disposal of toxic materials; and apply nutrients to establish and maintain vegetation.
3.3A	Existing Development	Includes the implementation of nonstructural controls to reduce pollutant loads and volume of storm water runoff.
3.4A	On-site Disposal Systems (OSDS) – New OSDSs	Includes comprehensive planning by the regulatory authority, including measures to protect sensitive areas, such as nutrient-limited waters and shellfish harvest areas. Measures might include prohibitions, setbacks, or requirements for the use of innovative treatment systems to effect greater treatment of sewage. Also includes performance-based requirements for the siting, design, and installation of systems, and inspection of newly installed systems.
3.4B	On-site Disposal Systems (OSDS) – Operating OSDSs	Addresses the programmatic aspects of OWTS management to ensure that systems that are installed as designed are inspected and maintained regularly to prevent failures. Public education about proper sewage treatment system use and maintenance is an important part of this measure, as is development and enforcement of policies to prevent or minimize the impacts of OWTS failures.
3.5A	Transportation Development – Planning, Siting, and	Aims to protect areas that provide important water quality benefits and limit land disturbance.

Exhibit C-3. Urban Management Measures

MM Code	Urban MM Title	Description
	Developing Roads and Highways	
3.5B	Transportation Development – Bridges	Aims to design bridges to minimize damage to riparian or wetland habitats and treating runoff from bridge decks before it is allowed to enter watercourses. Bridge maintenance activities should be conducted using containment practices to prevent pollutants from entering the water or riparian habitat below. Restoration of damaged riparian or instream habitats should be done after bridge construction, maintenance, and demolition.
3.5C	Transportation Development – Construction Projects	Implement a chemical control plan to: limit application, generation, and migration of toxic substances; ensure proper storage and disposal of toxic materials; and apply nutrients to establish and maintain vegetation.
3.5D	Transportation Development – Chemical Control	Implement a chemical control plan to: limit application, generation, and migration of toxic substances; ensure proper storage and disposal of toxic materials; and apply nutrients to establish and maintain vegetation.
3.5E	Transportation Development – Operation and Maintenance	Incorporate pollution prevention procedures into the operation and maintenance of roads, highways, and bridges to reduce pollutant loadings to surface waters.
3.5F	Transportation Development – Road, Highway, and Bridge Runoff Systems	Acknowledges the fact that roads built in the past may not have the same level of runoff control and treatment that is expected today, and these older roads may be contributing to pollution problems in receiving waters. Municipalities responsible for road and bridge rights-of-way should undertake an assessment of the roads' and bridges' contribution to surface waters and identify opportunities for installing new treatment practices. Based on water quality priorities and the availability of staff and funding resources, a schedule should be devised to implement these practices.
3.6A	Education/Outreach – Pollution Prevention: General Sources	Used to reduce the amount of pollutants generated or allowed to be exposed to runoff.

Source: SWRCB (2000).

There are 16 MMs to address marina and boating sources of nonpoint pollution (**Exhibit C-4**). Effective implementation of these MMs can ensure appropriate operation and maintenance practices and encourage the development and use of effective pollution control and education efforts. The MMs cover the following operations and facilities:

- Any facility that contains 10 or more slips, piers where 10 or more boats may tie up, or any facility where a boat for hire is docked
- Any residential or planned community marina with 10 or more slips
- Any mooring field where 10 or more boats are moored
- Public or commercial boat ramps
- Boat maintenance or repair yards on or adjacent to the water (typically, boat yards are separate entities from marinas and are regulated under NPDES storm water permits).

Exhibit C-4. Marinas and Boating Management Measures

MM Code	Marinas MM Title	Description
4.1A	Assessment, Siting and Design – Marina Flushing	Provides for maximum flushing and circulation of surface waters through marina siting and designs. These practices can reduce the potential for water stagnation, maintain biological productivity, and reduce the potential for toxic accumulation in bottom sediment.
4.1D	Assessment, Siting and Design – Shoreline Stabilization	Use of vegetative stabilization methods is preferred over the use of structural stabilization methods where shoreline erosion is a pollution problem.
4.1E	Assessment, Siting and Design – Storm Water runoff	Involves implementing runoff control strategies to remove at least 80 percent of suspended solids from storm water runoff coming from boat maintenance areas (some boat yards may conform to this provision through NPDES permits).
4.1F	Assessment, Siting and Design – Fueling Station Design	Requires that fueling stations be located and designed to contain accidental fuel spills in a limited area, and that fuel containment equipment and spill contingency plans be provided to ensure quick spill response.
4.1H	Assessment, Siting and Design – Waste Management Facilities	Requires that facilities be installed at new and expanding marinas where needed for the proper recycling or disposal of solid wastes (e.g., oil filters, lead acid batteries, used absorbent pads, spent zinc anodes, and fish waste as applicable) and liquid materials (e.g., fuel, oil, solvents, antifreeze, and paints).
4.2A	Operation and Maintenance – Solid Waste Control	Involves properly disposing of solid wastes produced by the operation, cleaning, maintenance, and repair of boats to limit entry of these wastes to surface waters.
4.2C	Operation and Maintenance – Liquid Material Control	Promotes sound fish waste management through a combination of fish cleaning restrictions, education, and proper disposal.
4.2D	Operation and Maintenance – Petroleum Control	Requires provision and maintenance of the appropriate storage, transfer, containment, and disposal facilities for liquid materials commonly used in boat maintenance, as well as encouraging the recycling of these materials.
4.2E	Operation and Maintenance – Boat Cleaning and Maintenance	Aimed at reducing the amount of fuel and oil that leaks from fuel tanks and tank air vents during the refueling and operation of boats.
4.2G	Operation and Maintenance – Boat Operation	Involves prevention of turbidity and physical destruction of shallow-water habitat resulting from boat wakes and prop wash.
4.3A	Education and Outreach – Public Education	Requires that public education, outreach, and training programs be instituted to prevent and control improper disposal of pollutants into State waters.

Source: SWRCB (2000).

State Water Resources Control Board (SWRCB). 2000. Nonpoint Source Program Strategy and Implementation Plan, 1998-2013. January.

Appendix D. Current Toxics 303(d) Listings and TMDLs

This appendix shows the 303(d) list impairments for toxic pollutants in bays and estuaries in California and provides a summary of the targets, sources, and potential implementation activities for TMDLs addressing toxic pollutants.

Exhibit D-1. Toxic Pollutant 303(d) List Impairments for Bays and Estuaries in California

Water Body Name	Sediment	Tissue	Water
Region 1			
Eureka Plain HU, Humboldt Bay			Dioxin Toxic Equivalents; PCBs
Region 2			
Carquinez Strait			Chlordane; DDT; Dieldrin; Dioxin compounds; Furan Compounds; Mercury; PCBs; PCBs (dioxin-like); Selenium
Castro Cove, Richmond (San Pablo Basin)	Dieldrin; Mercury; PAHs; Selenium		
Central Basin, San Francisco (part of SF Bay, Lower)	Mercury; PAHs		Chlordane; DDT; Dieldrin; Dioxin compounds; Furan Compounds; Mercury; PCBs; PCBs (dioxin-like); Selenium
Islais Creek	Chlordane; Dieldrin; PAHs; Sediment Toxicity		Hydrogen Sulfide
Mission Creek	Chlordane; Dieldrin; Lead; Mercury; PCBs; Silver; Zinc		Hydrogen Sulfide; PAHs
Oakland Inner Harbor (Fruitvale Site, part of SF Bay, Lower)	Chlordane; PCBs; Sediment Toxicity		Chlordane; DDT; Dieldrin; Dioxin compounds; Furan Compounds; Mercury; PCBs; PCBs (dioxin-like); Selenium
Oakland Inner Harbor (Pacific Dry-dock Yard 1 Site, part of SF Bay, Lower)	Chlordane; Copper; Dieldrin; Lead; Mercury; PAHs; PCBs; Zinc		Chlordane; DDT; Dieldrin; Dioxin compounds; Furan Compounds; Mercury; PCBs; PCBs (dioxin-like); Selenium
Pacific Ocean at Pillar Point			Mercury
Richardson Bay			Chlordane; DDT; Dieldrin; Dioxin compounds; Furan Compounds; Mercury; PCBs; PCBs (dioxin-like)
Sacramento San Joaquin Delta			Chlordane; DDT; Dieldrin; Dioxin compounds; Furan Compounds; Mercury; PCBs; PCBs (dioxin-like); Selenium
San Francisco Bay, Central			Chlordane; DDT; Dieldrin; Dioxin compounds; Furan Compounds; Mercury; PCBs; PCBs (dioxin-like); Selenium

Exhibit D-1. Toxic Pollutant 303(d) List Impairments for Bays and Estuaries in California

Water Body Name	Sediment	Tissue	Water
San Francisco Bay, Lower			Chlordane; DDT; Dieldrin; Dioxin compounds; Furan Compounds; Mercury; PCBs; PCBs (dioxin-like)
San Francisco Bay, South			Chlordane; DDT; Dieldrin; Dioxin compounds; Furan Compounds; Mercury; PCBs; PCBs (dioxin-like); Selenium
San Leandro Bay (part of SF Bay, Lower)	Lead; Mercury; PAHs; Pesticides; Zinc		Chlordane; Dieldrin; Dioxin compounds; Furan Compounds; Mercury
San Pablo Bay			Chlordane; DDT; Dieldrin; Dioxin compounds; Furan Compounds; Mercury; PCBs; PCBs (dioxin-like); Selenium
Stege Marsh			Chlordane; Copper; Dacthal; Dieldrin; Mercury; PCBs; Zinc
Suisun Bay			Chlordane; DDT; Dieldrin; Dioxin compounds; Furan Compounds; Mercury; PCBs; PCBs (dioxin-like); Selenium
Suisun Marsh Wetlands			Mercury
Suisun Slough			Diazinon
Tomales Bay			Mercury
Region 3			
Carpinteria Marsh (El Estero Marsh)			Priority Organics
Elkhorn Slough			Pesticides
Goleta Slough/Estuary			Priority Organics
Monterey Harbor	Sediment Toxicity		Metals
Moro Cojo Slough			Pesticides
Moss Landing Harbor	Sediment Toxicity		Chlorpyrifos; Diazinon; Nickel; Pesticides
Old Salinas River Estuary			Pesticides
Pacific Ocean (Point Ano Nuevo to Soquel Point)			Dieldrin
Pacific Ocean at Avila Beach (Avila Pier)			PCBs
Salinas River Lagoon (North)			Pesticides
Region 4			
Abalone Cove Beach	DDT		PCBs
Amarillo Beach			DDT; PCBs
Big Rock Beach			DDT; PCBs
Bluff Cove Beach			DDT; PCBs
Cabrillo Beach (Outer)			DDT; PCBs
Calleguas Creek Reach 1 (was Mugu Lagoon on 1998 303(d) list)	DDT; Sediment Toxicity	Chlordane; DDT; Endosulfan; PCBs	Copper; Dieldrin; Mercury; Nickel; Toxaphene; Zinc
Carbon Beach			DDT; PCBs
Castlerock Beach			DDT; PCBs

Exhibit D-1. Toxic Pollutant 303(d) List Impairments for Bays and Estuaries in California

Water Body Name	Sediment	Tissue	Water
Colorado Lagoon	Chlordane; Lead; PAHs; Sediment Toxicity; Zinc	Chlordane; DDT; Dieldrin; PCBs	
Dominguez Channel Estuary (unlined portion below Vermont Ave)	DDT; Sediment Toxicity; Zinc	Chlordane; DDT; Dieldrin; Lead	Benthic Community Effects; Benzo(a)pyrene; Benzo[a]anthracene; Chrysene (C1-C4); PCBs; Phenanthrene; Pyrene
Escondido Beach			DDT; PCBs
Flat Rock Point Beach Area			DDT; PCBs
Inspiration Point Beach			DDT; PCBs
La Costa Beach			DDT; PCBs
Las Flores Beach			DDT; PCBs
Las Tunas Beach			DDT; PCBs
Long Point Beach			DDT; PCBs
Los Angeles Harbor - Cabrillo Marina			Benzo(a)pyrene; DDT; PCBs
Los Angeles Harbor - Consolidated Slip	Cadmium; Chlordane; Chromium; Copper; DDT; Lead; Mercury; PCBs; Sediment Toxicity; Zinc	Chlordane; DDT; PCBs; Toxaphene	2-Methylnaphthalene; Benthic Community Effects; Benzo(a)pyrene; Benzo[a]anthracene; Chrysene (C1-C4); Dieldrin; Phenanthrene; Pyrene
Los Angeles Harbor - Fish Harbor	Sediment Toxicity		Benzo(a)pyrene; Benzo[a]anthracene; Chlordane; Chrysene (C1-C4); Copper; DDT; Dibenz[a,h]anthracene; Lead; Mercury; PAHs; PCBs; Phenanthrene; Pyrene; Zinc
Los Angeles Harbor - Inner Cabrillo Beach Area			DDT; PCBs
Los Angeles River Estuary (Queensway Bay)	Chlordane; DDT; PCBs; Sediment Toxicity		
Los Angeles/Long Beach Inner Harbor	Sediment Toxicity		Benthic Community Effects; Benzo(a)pyrene; Chrysene (C1-C4); Copper; DDT; PCBs; Zinc
Los Angeles/Long Beach Outer Harbor (inside breakwater)	Sediment Toxicity		DDT; PCBs
Los Cerritos Channel	Chlordane		Bis(2ethylhexyl)phthalate ; Copper; Lead; Zinc
Malaga Cove Beach			DDT; PCBs
Malibu Beach			DDT
Malibu Lagoon			Benthic Community Effects
Malibu Lagoon Beach (Surfrider)			DDT; PCBs

Exhibit D-1. Toxic Pollutant 303(d) List Impairments for Bays and Estuaries in California

Water Body Name	Sediment	Tissue	Water
Marina del Rey Harbor - Back Basins	Chlordane; Copper; Lead; PCBs; Sediment Toxicity; Zinc	Chlordane; DDT; Dieldrin; Fish Consumption Advisory; PCBs	
Nicholas Canyon Beach			DDT; PCBs
Palo Verde Shoreline Park Beach			Pesticides
Paradise Cove Beach			DDT; PCBs
Point Dume Beach			DDT; PCBs
Point Fermin Park Beach			DDT; PCBs
Port Hueneme Harbor (Back Basins)		DDT; PCBs	
Port Hueneme Pier			PCBs
Portuguese Bend Beach			DDT; PCBs
Puerco Beach			DDT; PCBs
Redondo Beach			DDT; PCBs
Robert H. Meyer Memorial Beach			DDT; PCBs
Royal Palms Beach			DDT; PCBs
San Pedro Bay Near/Off Shore Zones	DDT; Sediment Toxicity	DDT	Chlordane; PCBs
Santa Clara River Estuary			ChemA; Toxaphene; Toxicity
Santa Monica Bay Offshore/Nearshore	DDT; PCBs; Sediment Toxicity	DDT; Fish Consumption Advisory; PCBs	
Sea Level Beach			DDT; PCBs
Topanga Beach			DDT; PCBs
Trancas Beach (Broad Beach)			DDT; PCBs
Ventura Marina Jetties			DDT; PCBs
Whites Point Beach			DDT; PCBs
Zuma Beach (Westward Beach)			DDT; PCBs
Region 5			
Calaveras River, Lower (from Bellota Weir to Stockton Diverting Canal)			Unknown Toxicity
Delta Waterways (Stockton Ship Channel)			Chlorpyrifos; DDT; Diazinon; Dioxin; Furan Compounds; Group A Pesticides; Mercury PCBs; Unknown Toxicity
Delta Waterways (central portion)			Chlorpyrifos; DDT; Diazinon; Group A Pesticides; Mercury; Unknown Toxicity
Delta Waterways (eastern portion)			Chlorpyrifos; DDT; Diazinon; Group A Pesticides; Mercury; Unknown Toxicity
Delta Waterways (export area)			Chlorpyrifos; DDT; Diazinon; Group A Pesticides; Mercury; Unknown Toxicity
Delta Waterways (northern portion)			Chlordane; Chlorpyrifos; DDT; Diazinon; Group A Pesticides; Mercury; PCBs; Unknown Toxicity
Delta Waterways (northwestern portion)			Chlorpyrifos; DDT; Diazinon; Group A Pesticides; Mercury; Unknown Toxicity

Exhibit D-1. Toxic Pollutant 303(d) List Impairments for Bays and Estuaries in California

Water Body Name	Sediment	Tissue	Water
Delta Waterways (southern portion)			Chlorpyrifos; DDT; Diazinon; Group A Pesticides; Mercury; Unknown Toxicity
Delta Waterways (western portion)			Chlorpyrifos; DDT; Diazinon; Group A Pesticides; Mercury; Unknown Toxicity
Fresno Slough (from Graham Road to James Bypass, Fresno County)			Chlorpyrifos; Unknown Toxicity
Region 8			
Anaheim Bay	Sediment Toxicity	Dieldrin; PCBs	Nickel
Balboa Beach			DDT; Dieldrin; PCBs
Bolsa Chica State Beach			Copper; Nickel
Huntington Beach State Park			PCBs
Huntington Harbour	Sediment Toxicity	PCBs	Chlordane; Copper; Lead; Nickel
Newport Bay, Lower (entire lower bay, including Rhine Channel, Turning Basin and South Lido Channel to east end of H-J Moorings)	Sediment Toxicity		Chlordane; Copper; DDT; PCBs; Pesticides
Newport Bay, Upper (Ecological Reserve)	Sediment Toxicity		Chlordane; Copper; DDT; Metals; PCBs; Pesticides
Rhine Channel	Sediment Toxicity		Copper; Lead; Mercury; PCBs; Zinc
Seal Beach			PCBs
Region 9			
Dana Point Harbor			Copper; Toxicity; Zinc
Mission Bay (area at mouth of Rose Creek only)			Lead
Mission Bay (area at mouth of Tecolote Creek only)			Lead
Mission Bay at Quivira Basin			Copper
Oceanside Harbor			Copper
Pacific Ocean Shoreline, Imperial Beach Pier			PCBs
San Diego Bay			PCBs
San Diego Bay Shoreline, 32nd St San Diego Naval Station	Sediment Toxicity		Benthic Community Effects
San Diego Bay Shoreline, Chula Vista Marina			Copper
San Diego Bay Shoreline, Downtown Anchorage	Sediment Toxicity		Benthic Community Effects
San Diego Bay Shoreline, North of 24th Street Marine Terminal	Sediment Toxicity		Benthic Community Effects
San Diego Bay Shoreline, Seventh Street Channel	Sediment Toxicity		Benthic Community Effects
San Diego Bay Shoreline, Vicinity of B St and Broadway Piers	Sediment Toxicity		Benthic Community Effects
San Diego Bay Shoreline, at Americas Cup Harbor			Copper

Exhibit D-1. Toxic Pollutant 303(d) List Impairments for Bays and Estuaries in California

Water Body Name	Sediment	Tissue	Water
San Diego Bay Shoreline, at Coronado Cays			Copper
San Diego Bay Shoreline, at Glorietta Bay			Copper
San Diego Bay Shoreline, at Harbor Island (East Basin)			Copper
San Diego Bay Shoreline, at Harbor Island (West Basin)			Copper
San Diego Bay Shoreline, at Marriott Marina			Copper
San Diego Bay Shoreline, between Sampson and 28th Streets			Copper
San Diego Bay Shoreline, between Sampson and 28th Streets			Mercury; PAHs; PCBs; Zinc
San Diego Bay Shoreline, near Chollas Creek	Sediment Toxicity		Benthic Community Effects
San Diego Bay Shoreline, near Coronado Bridge	Sediment Toxicity		Benthic Community Effects
San Diego Bay Shoreline, near Switzer Creek			Chlordane PAHs
San Diego Bay Shoreline, near sub base	Sediment Toxicity		Benthic Community Effects; Toxicity
San Diego Bay, Shelter Island Yacht Basin			Copper, Dissolved
Tijuana River Estuary			Lead; Nickel; Pesticides; Thallium

Source: SWRCB (2010).

Exhibit D-2. Summary of Toxic Pollutant TMDLs for Bays and Estuaries

Numeric Targets	Load Allocations	Implementation
Ballona Creek Estuary Toxics TMDL (LARWQCB, 2005a)		
<u>Sediment:</u> Chlordane = 0.5 µg/kg; DDT = 1.58 µg/kg; PCBs = 22.7 µg/kg; PAHs = 4,022 µg/kg; Cadmium = 1.2 mg/kg; Copper = 34 mg/kg; Lead = 46.7 mg/kg; Silver = 1.0 mg/kg; Zinc = 15 mg/kg	<u>Direct Air:</u> Chlordane = 0.02 g/yr; DDT = 0.1 g/yr; PCBs = 1.0 g/yr; PAHs = 170 g/yr; Cadmium = 0.05 kg/yr; Copper = 1.4 kg/yr; Lead = 2 kg/yr; Silver = 0.04 kg/yr; Zinc = 6 kg/yr <u>Open Space:</u> Chlordane = 0.02 g/yr; DDT = 0.1 g/yr; PCBs = 1.0 g/yr; PAHs = 160 g/yr; Cadmium = 0.05 kg/yr; Copper = 1.4 kg/yr; Lead = 2 kg/yr; Silver = 0.04 kg/yr; Zinc = 6 kg/yr <u>General Construction SW:</u> Chlordane = 0.1 g/yr; DDT = 0.31 g/yr; PCBs = 4 g/yr; PAHs = 800 g/yr; Cadmium = 0.23 kg/yr; Copper = 6.6 kg/yr; Lead = 9.1 kg/yr; Silver = 0.2 kg/yr; Zinc = 29 kg/yr	Potential implementation strategies: • Implement nonstructural BMPs such as better sediment control at construction sites and improved street cleaning by upgrading to vacuum type sweepers for 30% of urbanized watershed • Install structural BMPs at critical points in the storm water conveyance system for 40% of urbanized watershed: 50% infiltration trenches and 50% sand filters. • The Regional Water Board assumed that the remaining 30% of urbanized land will be controlled through Los Angeles County's Integrated Resources Plan that aims to increase the amount of wet-weather urban runoff that can be captured and beneficially used. The Regional Water Board estimated that implementation of an adaptive management approach could costs from about $245 million to $335 million.

Exhibit D-2. Summary of Toxic Pollutant TMDLs for Bays and Estuaries

Numeric Targets	Load Allocations	Implementation
	General Industrial SW: Chlordane = 0.02 g/yr; DDT = 0.08 g/yr; PCBs = 1.0 g/yr; PAHs = 200 g/yr; Cadmium = 0.06 kg/yr; Copper = 1.7 kg/yr; Lead = 2.3 kg/yr; Silver = 0.05 kg/yr; Zinc = 7 kg/yr Caltrans: Chlordane = 0.05 g/yr; DDT = 0.15 g/yr; PCBs = 2 g/yr; PAHs = 400 g/yr; Cadmium = 0.11 kg/yr; Copper = 3.2 kg/yr; Lead = 4.4 kg/yr; Silver = 0.09 kg/yr; Zinc = 14 kg/yr MS4s: Chlordane = 3.34 g/yr; DDT = 10.56 g/yr; PCBs = 152 g/yr; PAHs = 26,900 g/yr; Cadmium = 8.0 kg/yr; Copper = 227.3 kg/yr; Lead = 312.3 kg/yr; Silver = 6.69 kg/yr; Zinc = 1,003 kg/yr	
Cache Creek Mercury TMDL (part of Delta watershed) (CVRWQCB, 2004a; 2004b; 2005b)		
Fish Tissue: Methylmercury trophic level 3 fish = 0.12 mg/kg Methylmercury trophic level 4 fish = 0.23 mg/kg	Mercury Allocations: Bear Creek mines = 5% of existing Hg loads (Rathburn, Petray North and South, and Rathburn-Petray); Harley Gulch mines = 5% of existing Hg loads (Abbott and Turkey Run); Sulphur Creek = 30% of existing Hg loads (geothermal springs, erosion of undisturbed soil, mines, contaminated streambeds, and atmospheric deposition) Methylmercury Allocations: Cache Creek at Yolo = 66 g MeHg/yr; Settling Basin = 34.7 g MeHg/yr; Bear Creek at gauge = 3.2 g MeHg/yr	Implementation options include: • Public outreach regarding the levels of safe fish consumption and monitoring • Remediation of inactive mines • Control of erosion in mercury-enriched upland areas and in floodplains downstream of the mines and in the lower watershed, • Conducting feasibility studies and evaluating possible remediation at the Harley Gulch delta • Identifying sites and projects to remediate or remove floodplain sediments containing mercury and implement feasible projects • Addressing methylmercury reductions through studies of sources and possible controls in Bear Creek and Anderson Marsh, controlling inputs from new impoundments, wetlands restoration projects, or geothermal spring development. The Regional Water Board estimated capital costs of $14 million and O&M of $700,000 per year.
Calleguas Creek Watershed Metals and Selenium TMDL[a] (LARWQCB, 2006)		
Dry Weather Water: Dissolved Copper = 3.1 × WER**; Dissolved Nickel = 8.2 μg/L; Total Mercury = 0.051 μg/L Wet Weather Water: Dissolved Copper = 4.8 × WER**; Dissolved Nickel = 74 μg/L; Total Mercury = 0.051 μg/L Sediment: Copper = 34,000 μg/kg; Nickel = 20,900 μg/kg	Suspended Sediments: Mercury = 80% reduction below background concentrations Average Dry Weather (<86th Percentile Flow): Agriculture: Copper = 0.12 × WER** - 0.02 lbs/day; Nickel = 0.26 lbs/day Open Space: Copper = 0.08 lbs/day; Nickel = 0.42 lbs/day NPDES Dischargers: Copper	Implementation options include: • Establish group concentration-based effluent limits for NPDES dischargers • Implement BMPs for nonpoint sources consistent with the Nonpoint Source Plan and Conditional Waiver Program.

Exhibit D-2. Summary of Toxic Pollutant TMDLs for Bays and Estuaries

Numeric Targets	Load Allocations	Implementation
Fish Tissue: Methylmercury = 0.3 mg/kg (human health); Methylmercury Trophic Level 3 <50 mm = 0.03 mg/kg; Methylmercury Trophic Level 3 50-150 mm = 0.05 mg/kg; Methylmercury Trophic Level 3 150-350 mm = 0.1 mg/kg Bird Egg: Mercury = 0.5 mg/kg	Monthly Average = 3.7 × WER** µg/L; Nickel Monthly Average = 8.2 µg/L; Mercury = 0.051 µg/L Wet Weather: Agriculture: Copper = (0.00017 × flow^2 × 0.01 × flow – 0.05) × WER** - 0.02 lbs/day; Nickel = 0.014 × flow + 0.42 × flow lbs/day Open Space: Copper = 0.0000537 × flow^2 + 0.00321 × flow lbs/day; Nickel = 0.014 × flow + 0.42 × flow lbs/day NPDES Dischargers: Copper Daily Maximum = 5.8 × WER** µg/L; Nickel Daily Maximum = 74 µg/L; Mercury = 0.051 µg/L	
Calleguas Creek Watershed OC Pesticides and PCBs TMDL[a] (LARWQCB, 2005e)		
Sediment: Chlordane = 0.5 µg/kg; DDT = 1 µg/kg; Dieldrin = 20 ng/kg; PCBs = 23 µg/kg Water: Chlordane = 4 ng/L; DDT = 1 ng/L; Dieldrin = 1.9 ng/L; PCBs = 30 ng/L; Toxaphene = 0.2 ng/L Fish Tissue: Chlordane = 0.83 µg/kg; DDT = 32 µg/kg; Dieldrin = 0.65 µg/kg; PCBs = 5.3 µg/kg; Toxaphene = 9.8 µg/kg	Storm Water Permits: Chlordane = 3.3 ng/g; DDT = 0.3 ng/g; Dieldrin = 4.3 ng/g; PCBs = 180 ng/g; Toxaphene = 360 ng/g Minor Point Sources Daily Maximum: Chlordane = 1.2 ng/L; DDT = 1.2 ng/L; Dieldrin = 0.28 ng/L; PCBs = 0.33 ng/L; Toxaphene = 0.34 ng/L Minor Point Sources Average Monthly: Chlordane = 0.59 ng/L; DDT = 0.59 ng/L; Dieldrin = 0.14 ng/L; PCBs = 0.17 ng/L; Toxaphene = 0.16 ng/L	Implementation options include: • Establish group concentration-based effluent limits for NPDES dischargers • Implement BMPs for nonpoint sources consistent with the Nonpoint Source Plan and Conditional Waiver Program. • Develop Agricultural Water Quality Management Plans and implement agricultural BMPs based on results of BMP effectiveness studies • Develop agricultural education program to inform growers of the recommended BMPs and the Management Plan.
Delta Waterways Methylmercury TMDL (CVRWQCB, 2005a)		
Fish Tissue: Methylmercury for largemouth bass = 0.28 mg/kg	Methylmercury Allocations: Central Delta = current load; Marsh Creek = 1.8 g MeHg/yr; Mokelumne-Cosumnes Rivers = 44 g MeHg/yr; Sacramento River = 1,341 g MeHg/yr; San Joaquin = 178 g MeHg/yr; West Delta = current load; Yolo Bypass = 234 g MeHg/yr Total Mercury Allocations: All mercury sources to delta = 174,000 g Hg/yr	Draft implementation options include: • Improve trapping efficiency in Cache Creek Settling Basin • Require that dredged spoil with average concentrations greater than 0.2 mg/kg be placed on or above the 100-year flood plain • Require mercury concentration of fine grain material in top 6-cm of newly exposed sediment to have an average concentration less than the surface material before dredging or be less than 0.2 mg/kg dry weight • Cap NPDES discharger loads at 2005 levels • Implement P2 at facilities with increasing loads • Allow facilities that show maintaining cap is technically impractical or excessively expensive to participate in offsets program • Implement studies to enable reduction of methylmercury in Delta waters.
Marina del Rey Toxics TMDL (LARWQCB, 2005b)		
Sediment: Chlordane = 0.5	Atmospheric Deposition:	Potential implementation strategies:

Exhibit D-2. Summary of Toxic Pollutant TMDLs for Bays and Estuaries

<table>
<tr><th>Numeric Targets</th><th>Load Allocations</th><th>Implementation</th></tr>
<tr><td>µg/kg; PCBs = 22.7 µg/kg; Copper = 34 mg/kg; Lead = 46.7 mg/kg; Zinc = 150 mg/kg
<u>Water Quality</u>: PCBs = 0.17 ng/L (interim); PCBs = 30 ng/L (final)
<u>Fish Tissue</u>: PCBs = 5.3 µg/kg</td><td>Chlordane = 0.002 g/yr; PCBs = 0.079 g/yr; Copper = 0.12 kg/yr; Lead = 0.16 kg/yr
Zinc = 0.52 kg/yr
<u>General Construction SW</u>: Chlordane = 0.0005 g/yr; PCBs = 0.0219 g/yr; Copper = 0.033 kg/yr; Lead = 0.045 kg/yr; Zinc = 0.144 kg/yr
<u>General Industrial SW</u>: Chlordane = 0.0001 g/yr; PCBs = 0.029 g/yr; Copper = 0.004 kg/yr; Lead = 0.006 kg/yr; Zinc = 0.018 kg/yr
<u>Caltrans</u>: Chlordane = 0.0003 g/yr; PCBs = 0.015 g/yr; Copper = 0.022 kg/yr; Lead = 0.030 kg/yr; Zinc = 0.096 kg/yr
<u>MS4s</u>: Chlordane = 0.03 g/yr; PCBs = 1.34 g/yr; Copper = 2.01 kg/yr; Lead = 2.75 kg/yr; Zinc = 8.85 kg/yr</td><td>• Implement nonstructural BMPs such as better sediment control at construction sites and improved street cleaning by upgrading to vacuum type sweepers for 30% of urbanized watershed
• Install structural BMPs at critical points in the storm water conveyance system for 70% of urbanized watershed: 50% infiltration trenches and 50% sand filters.
The Regional Water Board estimated structural storm water BMP implementation costs to range from about $5.5 million to $7.6 million.</td></tr>
<tr><td colspan="3">Upper and Lower Newport Bay (including Rhine Channel) Metals TMDL (U.S. EPA Region 9, 2002; Anchor Environmental, 2006)</td></tr>
<tr><td><u>Sediment Quality:</u> Cadmium: 0.67 mg/kg; Copper: 18.7 mg/kg; Lead: 30.2 mg/kg; Zinc: 124 mg/kg; Mercury = 0.13 mg/kg; Chromium = 52 mg/kg
<u>Acute Water Quality:</u> Cadmium: 42 µg/L; Copper: 4.8 µg/L; Lead: 210 µg/L; Zinc: 90 µg/L
<u>Chronic Water Quality</u>: Cadmium: 9.3 µg/L; Copper: 3.1 µg/L; Lead: 8.1 µg/L; Zinc: 81 µg/L
<u>Fish Tissue</u>: Mercury = 0.3 mg/kg; Chromium = 0.2 mg/kg</td><td><u>Urban runoff</u>: Cadmium = 9,589 lb/yr; Copper = 3,043 lb/yr; Lead = 17,638 lb/yr; Zinc = 174,057 lb/yr; Mercury = 17.1 g/yr; Chromium = 5.66 kg/yr
<u>Caltrans</u>: Cadmium = 1,185 lb/yr; Copper = 423 lb/yr; Lead = 2,171 lb/yr; Zinc = 22,866 lb/yr; Mercury = 2.7 g/yr; Chromium = 0.89 kg/yr
<u>Other NPDES Permittees</u>: Cadmium = 596 lb/yr; Copper = 190 lb/yr; Lead = 1,154 lb/yr; Zinc = 17,160 lb/yr; Mercury = 2.7 g/yr; Chromium = 0.89 kg/yr
<u>Agriculture</u>: Copper = 215 lb/yr; Zinc = 114 lb/yr; Mercury = 0 g/yr; Chromium = 0.89 kg/yr
<u>Boats</u>: Copper = 4,542 lb/yr; Zinc = 1,056 lb/yr
<u>Air Deposition</u>: Cadmium = 4 lb/yr; Copper = 101 lb/yr; Lead = 68 lb/yr; Zinc = 606 lb/yr
<u>Open Space and Existing Sediments</u>: Cadmium = 428 lb/yr; Copper = 803 lb/yr; Lead = 678 lb/yr; Zinc = 11,414 lb/yr; Mercury = 67.5 g/yr; Chromium = 22.3 kg/yr</td><td>RWQCB is considering the following options for the Rhine Channel (in Lower Newport Bay):
• Dredge sediment and dewater prior to transporting to an approved off-site upland disposal facility ($11 million to $17 million)
• Dredge sediment and place within an off-site nearshore confined disposal facility ($7.5 million)
• Dredge sediment and dispose of within a confined aquatic disposal area excavated near channel mouth ($12.6 million).
First option shown is preferred option.</td></tr>
<tr><td colspan="3">Upper and Lower Newport Bay Organochlorine Compounds TMDL (SARWQCB, 2006)</td></tr>
</table>

Exhibit D-2. Summary of Toxic Pollutant TMDLs for Bays and Estuaries

Numeric Targets	Load Allocations	Implementation
Sediment Quality: Chlordane = 2.26 µg/kg; DDT = 3.89 µg/kg; PCBs = 21.5 µg/kg Fish Tissue: Chlordane = 30 µg/kg; DDT = 50 µg/kg; PCBs = 20 µg/kg Water Quality: Chlordane = 0.59 ng/L; DDT = 0.59 ng/L; PCBs = 0.17 ng/L	Urban runoff*: Chlordane = 41.1 g/yr; DDT = 70.9 g/yr; PCBs = 107.9 g/yr Caltrans*: Chlordane = 12.6 g/yr; DDT = 21.6 g/yr; PCBs = 33 g/yr Construction*: Chlordane = 32 g/yr; DDT = 55.2 g/yr; PCBs = 83.9 g/yr Commercial Nurseries: Chlordane = 4.5 g/yr; DDT = 7.9 g/yr; PCBs = 12 g/yr Agriculture*: Chlordane = 9.5 g/yr; DDT = 9.9 g/yr; PCBs = 17.8 g/yr Open Space: Chlordane = 10.4 g/yr; DDT = 17.8 g/yr; PCBs = 27 g/yr Channels and Streams: Chlordane = 2.3 g/yr; DDT = 4.0 g/yr; PCBs = 6.0 g/yr Existing Sediments and Air Deposition*: Chlordane = 5.7 g/yr; DDT = 9.9 g/yr; PCBs = 15 g/yr	The Regional Water Board recommends the following implementation actions: • Review and revise existing NPDES permits to incorporate wasteload allocations (WLAs), compliance schedules, and monitoring program requirements. • Require agricultural operators to identify and implement monitoring program to assess pollutant discharges from their facilities, and to identify and implement a BMP program. • Identify parties responsible for open space areas, and implement a monitoring program to assess the discharges. • Implement appropriate BMPs and sampling plans for construction activities. • MS4s shall implement additional/enhanced BMPs to ensure pollutant reductions. • Evaluate feasibility and mechanisms to fund future dredging operations. • Develop a work plan to meet TMDL implementation requirements. • Revise regional monitoring program to evaluate effectiveness of actions and programs. • Conduct special studies to review and revise TMDLs.
San Diego Bay, Shelter Island Yacht Club Dissolved Copper TMDL (SDRWQCB, 2005)		
Acute Water Quality: 4.8 µg/L Chronic Water Quality: 3.1 µg/L	Passive Leaching: 375 kg Cu/yr Hull Cleaning: 72 kg Cu/yr Urban Runoff: 30 kg Cu/yr Background: 30 kg Cu/yr Direct Atmospheric Deposition: 3 kg Cu/yr Existing Sediment: 0 kg Cu/yr	The Regional Water Board recommends the following implementation actions: • Coordinate with governmental agencies over the use of copper-based antifouling paints to protect water quality from the adverse effects of copper-based antifouling paints • Regulate discharges of copper through WDRs, waivers of WDRs, or adoption of waste discharge prohibitions • Amend MS4 permit to include 30 mg/kg copper limit.
San Francisco Bay Mercury TMDL (SFBRWQCB, 2004a)		
Sediment Quality: 0.2 mg Hg/kg Fish Tissue: 0.2 mg Hg/kg Wildlife, Birds Egg: 0.5 mg Hg/kg	Bed erosion: 220 kg Hg/yr (53% reduction) Central Valley watershed: 330 kg Hg/yr (24% reduction) Urban storm water runoff: 82 kg Hg/yr (48% reduction) Guadalupe River watershed: 2 kg Hg/yr (98% reduction) Atmospheric deposition: 27 kg Hg/yr (current load) Nonurban storm water runoff: 25 kg Hg/yr (current load) Wastewater: 20 kg Hg/yr (current load; 17 kg Hg/yr municipal; 3 kg Hg/yr industrial)	The proposed implementation plan identified actions for each source except bed erosion and nonurban storm water runoff because more information is needed. • Central Valley watershed: developing TMDL to meet allocation; actions likely to include mine remediation and sediment capture • Urban storm water runoff: comply with NPDES permits and implement pollution prevention (P2) • Guadalupe R. watershed: developing TMDL to meet allocation; actions likely to include mining waste removal and slope stabilization • Atmospheric deposition: no mandated action • Wastewater: capped at current loads.

Exhibit D-2. Summary of Toxic Pollutant TMDLs for Bays and Estuaries

Numeric Targets	Load Allocations	Implementation
San Francisco Bay PCBs TMDL (SFBRWQCB, 2004b)		
Sediment Quality: 2.5 µg PCBs/kg Fish Tissue: 22 ng PCBs/g	Atmospheric Deposition: -7 kg PCBs/yr Central Valley Delta: 32 kg/yr Wastewater Discharges: 2.3 kg/yr Urban Runoff: 2 kg/yr Dredged Material: 1.4 kg/yr In-Bay PCBs Hot Spots: Not quantified	The Regional Water Board recommends the following implementation actions: • Develop a watershed-wide NPDES permit for all point source dischargers that caps current loads • Implement source control programs for point source dischargers • Require petroleum refineries to evaluate the significance of PCB air emissions to load to bay • Cleanup of hotspots on land, storm drains, and vicinity of storm drain outfalls • Capture, detention, and treatment of highly contaminated runoff (where cleanup is not effective) • Implementation of urban runoff management practices and controls that remove PCBs • Implementation and attainment of the Long Term Management Strategy in-Bay disposal goals • Remediate PCBs contaminated sediments according to site-specific clean-up plans.

*Includes Upper and Lower Newport Bay allocations.

** The WER has a default value of 1.0 unless the Regional Water Board approves a site-specific WER. The Regional Water Board is reviewing a WER study for Mugu Lagoon (Reach 1), and if approved, the Regional Water Board will modify the TMDL targets in accordance with all legal and regulatory requirements.

a. Only includes pollutants from Exhibit 2-1 and allocations for Mugu Lagoon/Calleguas Creek Reach 1.

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Appendix E. Toxic Hot Spots for Bays and Estuaries

This appendix provides additional information on the enclosed bays listed as known toxic hot spots in the Consolidated Plan. **Exhibit E-1** summarizes the information in the Consolidation Plan for bays.

Exhibit E-1. Enclosed Bays Listed as Known Toxic Hot Spots

Rank	Site Identification	Reason for Listing	
		Definition trigger	Pollutants
High	Delta Estuary, Cache Creek watershed including Clear lake	Human health impacts	Mercury
High	Delta Estuary	Aquatic life impacts	Diazinon
High	Delta Estuary - Morrison Creek, Mosher Slough, 5 Mile Slough, Mormon Slough & Calaveras River	Aquatic life impacts	Diazinon & Chlorpyrifos
High	Delta Estuary - Ulatis Creek, Paradise Cut, French Camp & Duck Slough	Aquatic life impacts	Chlorpyrifos
High	Humboldt Bay Eureka Waterfront H Street	Bioassay toxicity	Lead, Silver, Antimony, Zinc, Methoxychlor, PAHs
High	Los Angeles Inner Harbor Dominguez Channel, Consolidated Slip	Human health, aquatic life impacts	DDT, PCBs, PAH, Cadmium, Copper, Lead, Mercury, Zinc, Dieldrin, Chlordane
High	Los Angeles Outer Harbor Cabrillo Pier	Human health, aquatic life impacts	DDT, PCBs, Copper
High	Lower Newport Bay Rhine Channel	Sediment toxicity, exceeds objectives	Arsenic, Copper, Lead, Mercury, Zinc, DDE, PCB, TBT
High	Moss Landing Harbor and Tributaries	Sediment chemistry, toxicity, bioaccumulation, and exceedances of NAS and FDA guidelines	Pesticides, PCBs, Nickel, Chromium, TBT
High	Mugu Lagoon/ Calleguas Creek tidal prism, Eastern Arm, Main Lagoon, Western Arm	Aquatic life impacts	DDT, PCBs, metals, Chlordane, Chlorpyrifos
High	San Diego Bay Seventh St. Channel Paleta Creek, Naval Station	Sediment toxicity and benthic community impacts	Chlordane, DDT, PAHs and Total Chemistry[2]
High	San Francisco Bay Castro Cove	Aquatic life impacts	Mercury, Selenium, PAHs, Dieldrin
High	San Francisco Bay Entire Bay	Human health impacts	Mercury, PCBs, Dieldrin, Chlordane, DDT, Dioxin Site listing was based on Mercury and PCB health advisory
High	San Francisco Bay, Islais Creek	Aquatic life impacts	PCBs, chlordane, dieldrin, endosulfan sulfate, PAHs, anthropogenically enriched H_2S and NH_3
High	San Francisco Bay Mission Creek	Aquatic life impacts	Silver, Chromium, Copper Mercury, Lead, Zinc, Chlordane, Chlorpyrifos, Dieldrin, Mirex, PCBs, PAHs, anthropogenically enriched H_2S and NH_3
High	San Francisco Bay, Peyton Slough	Aquatic life impacts	Silver, Cadmium, Copper, Selenium, Zinc, PCBs, Chlordane, ppDDE, Pyrene

Exhibit E-1. Enclosed Bays Listed as Known Toxic Hot Spots

Rank	Site Identification	Reason for Listing	
		Definition trigger	Pollutants
High	San Francisco Bay Point Potrero/ Richmond Harbor	Human health	Mercury, PCBs, Copper, Lead, Zinc
High	San Francisco Bay Stege Marsh	Aquatic life impacts	Arsenic, Copper, Mercury, Selenium, Zinc, chlordane, dieldrin, ppDDE, dacthal, endosulfan, endosulfan sulfate, dichlorobenzophenone, heptachlor epoxide, hexachlorobenzene, mirex, oxidiazon, toxaphene and PCBs
Moderate	Anaheim Bay, Naval Reserve	Sediment toxicity	Chlordane, DDE
Moderate	Ballona Creek Entrance Channel	Sediment toxicity	DDT, zinc, lead, Chlordane, dieldrin, chlorpyrifos
Moderate	Bodega Bay-10006 Mason's Marina	Bioassay toxicity	Cadmium, Copper, TBT, PAH
Moderate	Bodega Bay-10028 Porto Bodega Marina	Bioassay toxicity	Copper, lead, Mercury, Zinc, TBT, DDT, PCB, PAH
Moderate	Delta Estuary	Aquatic life impacts	Chlordane, Dieldrin, Lindane, Heptachlor, Total PCBs, PAH & DDT
Moderate	Delta Estuary	Human health impacts	Chlordane, Dieldrin, Total DDT, PCBs, Endosulfan, Toxaphene
Moderate	Los Angeles River Estuary	Sediment toxicity	DDT, PAH, Chlordane
Moderate	Upper Newport Bay Narrows	Sediment toxicity, exceeds water quality objectives	Chlordane, Zinc, DDE
Moderate	Lower Newport Bay Newport Island	Exceeds water quality objectives	Copper, Lead, Mercury, Zinc, Chlordane, DDE, PCB, TBT
Moderate	Marina del Rey	Sediment toxicity	DDT, PCB, Copper, Mercury, Nickel, Lead, Zinc, Chlordane
Moderate	Monterey Harbor	Aquatic life impacts, sediment toxicity	PAHs, Cu, Zn, Toxaphene, PCBs, Tributyltin
Moderate	San Diego Bay Between "B" Street & Broadway Piers	Benthic community impacts	PAHs, Total Chemistry
Moderate	San Diego Bay, Central Bay Switzer Creek	Sediment toxicity	Chlordane, Lindane, DDT, Total Chemistry
Moderate	San Diego Bay, Chollas Creek	Benthic community impacts	Chlordane, Total Chemistry
Moderate	San Diego Bay, Foot of Evans & Sampson Streets	Benthic Community Impacts	PCBs, Antimony, Copper, Total Chemistry
Moderate	San Francisco Bay Central Basin	Aquatic life impacts	Mercury, PAHs
Moderate	San Francisco Bay, Fruitvale (in front of storm drain)	Aquatic life impacts	Chlordane, PCBs
Moderate	San Francisco Bay Oakland Estuary. Pacific Drydock #1 (in front of storm drain)	Aquatic life impacts	Copper, Lead, Mercury, Zinc, TBT, ppDDE, PCBs, PAHs, Chlorpyrifos, Chlordane, Dieldrin, Mirex
Moderate	San Francisco Bay, San Leandro Bay	Aquatic life impacts	Mercury, Lead, Selenium, Zinc, PCBs, PAHs, DDT, pesticides
Low	Huntington Harbor Upper Reach	Sediment toxicity	Chlordane, DDE, Chlorpyrifos

Source: SWRCB (2003).

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Appendix F. Control Costs

This appendix provides a description of the types of the control costs that might be incurred as incremental costs of the Plan amendments should entities need to implement controls that would not be necessary in the absence of the Plan.

F.1 Storm Water Nonstructural BMPs

Street sweeping programs are often among the more costly nonstructural BMPs, accounting for approximately 11% to 64% of SWMP costs incurred by municipalities responding to a recent survey (CSU Sacramento, 2005). More intensive sweeping could include incremental costs for equipment purchase and operation. The effectiveness of street sweeping depends on the type and operation of the equipment, sweeping frequency and number of passes, and climate (FHWA, 2002). Thus, increasing the frequency of sweeping or changing the type of sweeper used may result in decreases in pollutant loads.

California State University (CSU) Sacramento conducted a storm water cost survey for the State Water Board to document costs incurred by select municipalities in implementing SWMPs as part of their MS4 NPDES permits. **Exhibit F-1** shows street sweeping costs for several California municipalities, with costs ranging from $12 to $61 per curb mile. Incremental costs for more extensive sweeping would depend on a municipality's current sweeping practices and the extent of the increase needed to reduce toxic loadings (e.g., the incremental curb miles and whether new sweepers need to be purchased).

Exhibit F-1. Examples of Street Sweeping Costs

Municipality	Street Sweeping Costs ($)	Annual Curb Miles Swept	Cost Per Curb Mile Swept ($/curb mile)	Estimated Annual Frequency
Fremont	$1,915,000	31,405	$61	12
Sacramento	$1,322,748	26,450	$50	12
Encinitas	$117,962	5,832	$20	12
Corona	$414,215	20,877	$20	26
Fresno-Clovis	$2,193,296	142,411	$15	12
Santa Clarita	$557,443	46,800	$12	50

Source: CSU Sacramento (2005).
1. Costs are in 2002/2003 fiscal year dollars.

Most municipalities use mechanical/brush model sweepers (Minton, 2007). These models are generally only half as effective as vacuum sweepers with respect to pollutant loading reduction. Vacuum sweepers are much more effective at removing fine sediments, silts and clays where much of the pollution resides. There are two types of vacuum sweepers: wet and dry. The dry vacuum sweepers remove a greater percentage of small particulates and sediments than the wet vacuum sweepers. Thus, depending on the load reductions needed, switching to either a wet or dry vacuum sweeper could increase pollutant load reductions to surface waters.

Conventional mechanical sweepers cost approximately $69,000 (1995 dollars), whereas wet vacuum sweepers cost around $127,000 (1995 dollars) (FHWA, 2002). The useful life span of these sweepers is between 4 and 7 years, and the operating cost associated with these sweepers is about $70 per hour (1996 dollars) (FHWA, 2002). The capital cost of vacuum-assisted dry sweepers is on the order of $170,000 (1996 dollars) with a projected useful life span of about 8 years, and operating costs of approximately $35 per hour (1996 dollars) (FHWA, 2002).

F.2 Storm Water Structural Controls

There are a variety of structural means to control the quantity and quality of storm water runoff including infiltration systems, detention systems, retention systems, constructed wetlands, filtration systems, and vegetated systems. The cost of constructing storm water controls depends on site conditions and drainage area. Furthermore, there are often economics of scale, making it difficult to develop a unit construction cost.

Caltrans conducted a storm water control retrofit pilot program to acquire experience in the installation and operation of a wide range of structural controls and to evaluate the performance and costs of these devices (Caltrans, 2004). As part of this program, Caltrans compared the construction costs incurred during the program to costs collected from several other transportation departments and jurisdictions (Caltrans, 2001). Caltrans obtained cost data from the following entities: Maryland State Highway Administration, Texas Department of Transportation, City of Austin (Texas), King County (Washington), Florida Department of Environmental Quality, Maryland and Virginia BMP data collected by the Center for Watershed Protection, and City of Santa Monica (California). **Exhibit F-2** presents Caltrans' unit cost estimates for these municipalities.

Exhibit F-2. Storm Water Control Cost Summary (2007$)[1]

Control Type	Number of Projects	Approximate Unit Cost ($/acre)			
		Median	Average	Max	Min
Detention Basin	23	$4,901	$6,983	$32,336	$470
Retention Basin (Wet Pond)	23	$8,287	$13,122	$55,883	$1,625
Wetland	25	$4,807	$7,859	$37,641	$271
Infiltration Trench	8	$15,395	$24,626	$65,737	$7,127
Austin Sand Filter	15	$24,307	$40,737	$171,438	$1,828
Delaware Sand Filter	4	$118,933	$117,938	$193,484	$40,404
Bioretention	2	$60,498	$60,498	$95,582	$25,414

Source: Caltrans (2001); escalated to 2007 dollars (from 1999 dollars) using the CCI.

1. Does not include Caltrans pilot program costs. Caltrans adjusted all costs for difference in regional economics and date of construction using RS Means Heavy Construction Cost Data and the CCI, respectively.

However, the costs incurred by Caltrans for BMPs constructed during their retrofit program are, in general, substantially higher than costs reported by the other entities Caltrans used for comparison. Caltrans (2001) indicated several reasons for these higher costs:

- Experience and efficiency in planning and design can contribute significantly to savings; Caltrans had relatively little experience and a relatively short planning horizon.
- BMP retrofit work was not combined with any ongoing construction projects.
- Pilot program did not reflect lowest cost technology for a given site.

Caltrans estimated that the retrofit program costs could be lowered by between 41% and 76%. Therefore, although the retrofit program provides valuable information related to storm water controls, the costs are likely to overstate those that would be incurred by other entities for the same practices.

The Westside Water Quality Improvement (WWQI) Project is an example of a structural storm water control project designed and constructed in California. The WWQI Project is a system designed to treat, to the maximum extent possible, dry weather and storm water runoff from eastern parts of Santa Monica and parts of west Los Angeles. The system is capable of treating dry weather runoff up to 3 cubic feet per second (cfs) and storm water runoff up to 33 cfs in a 24-hour period. The runoff comes from approximately 220 acres within Santa Monica's Centinela Sub-Watershed area and 2,280 acres from parts of west Los Angeles (CSM, No Date).

The facility utilizes three separate processes to treat and improve the quality of runoff: screening, sedimentation, and direct filtration. Direct filtration takes place in the Contech Stormwater Management StormFilter® unit which removes oil and grease, dissolved heavy metals, herbicides and pesticides. Removal of trash and other floatables, and suspended particulates by sedimentation occurs in the StormFilter, Bio Clean Nutrient Separating Baffle Box™, and at the transverse diversion weir (CSM, No Date). The facility operates totally on a gravity follow basis. Isolation gate valves may be closed for maintenance or to protect the system from being overloaded during heavy storm events (typically once or twice in a season) (CSM, No Date). The estimated cost of this project was approximately $2 million (ACC, 2007).

F.3 Controls for Marinas

Coastal Boatworks in Morro Bay, California completed a pollution prevention project in 1999 to reduce the amount of heavy metals and toxic pollutants that reached the bay from the marina. In addition to distributing 500 pamphlets to various agencies and organizations promoting pollution prevention along the waterfront, the facility also purchased new cleaning equipment including dustless sanders and a Vacu-boom system (used to prevent runoff from washing operations) for boaters to use during maintenance operations (MBNEP, 2000). The marina spent approximately $14,500 on the program (includes $5,400 in funding from the MBNEP) (MBNEP, 2000).

The Vacu-boom system is a hollow, flexible tube placed directly on a hard surface to form a downslope side dam or to completely encircle the wash or containment area. During use, the boom is connected by a portable wet vacuum recovery unit (Pressure Power Systems, 2007). When the wet vacuum system is turned on, the Vacu-Boom tightly seals itself to the surface to form an impervious liquid barrier and water is extracted into the boom into the vacuum unit (Pressure Power Systems, 2007). The water is discharged from the vacuum unit through a discharge hose into a holding tank, filter unit, or sanitary sewer (Pressure Power Systems, 2007). **Exhibit F-3** shows costs for various size units.

Exhibit F-3. Capital Costs for Vacu-Boom System (2007 dollars)

Tube Size	Capital Cost[1]
20 feet	$3,200
25 feet	$3,350
30 feet	$3,600
40 feet	$4,100
50 feet	$4,500

Source: Pressure Power Systems (2007).
1. Includes cost of shipping.

The Los Angeles Regional Water Board, among others, has identified copper-based antifouling paints as a source of copper pollution in marinas and bays (LARWQCB, 2005a; 2005b). Reduction or elimination of this pollution may require the transition to alternatives. Few, if any, areas in California have begun the transition to less toxic alternatives. The San Diego Regional Water Board (2005) provides information on the potential costs associated with the use of nontoxic paints on boats, based on findings in Carson, et al. (2002). **Exhibit F-4** provides a comparison between copper-based antifouling paints and nontoxic epoxy coatings. Boat owners may save small amounts of money on nontoxic hull coatings and maintenance over the life of the boat. In some situations, individual boat owners could spend slightly more money on nontoxic coating maintenance but the amount will be small compared to hull maintenance cost over the life of the boat (SDRWQCB, 2005).

Exhibit F-4. Comparison of Copper-Based Antifouling Paints to Nontoxic Epoxy Coatings[1]

Copper-Based Antifouling Paints	Nontoxic Epoxy Coatings
Initially less expensive to apply ($30 per foot)	Initially more expensive to apply ($30 - $50 per foot)
Do not need to be cleaned as often (14 times per year)	Need to be cleaned more often (22 times per year)
Need to be reapplied more often (every 2.5 years)	Do not need to be re-applied very often (every 5 years to 10 years)
Need to be stripped about every 6th application (every 15 years if paint reapplied every 2.5 years)	Do not need to be stripped (in first 30 – 60 years)

Source: SDRWQCB (2005).

1. Based on a typical stylized 40-foot long boat with 11-foot beam width and 375 square feet of wetted hull surface.

Variability in costs from this transition depends primarily on whether stripping for a boat is required prior to application of the nontoxic alternative. Stripping is not needed for new, unpainted boats. For older boats (approximately 15 years old), stripping is required for both application of nontoxic epoxy coatings, and continued application of copper-based paints. Thus, only boats less than 15 years old would have the option of stripping prior to applying the new paint. Stripping costs are approximated at $120/foot (Carson, et al., 2002). Long term cost estimates for transitioning from copper-based antifouling paints to nontoxic coatings also vary depending on assumptions regarding the performance of the nontoxic coatings and their price (SDRWQCB, 2005).

For example, Carson, et al. (2002) estimated the cost of remaining life hull maintenance for 40 foot length, 11 foot width boats to range from a savings of $1,354 (new boat with nontoxic coating, good performance, and lower prices) to a cost of $6,251 (2.5 year old boat requiring stripping, fair performance, and higher prices). Carson, et al. (2002) estimated that the least costly alternative for the transition to nontoxic paint (i.e., allowing boat owners to convert when the epoxy-copper cost differential is most favorable) would cost the boating community (about 7,000 boats) in San Diego Bay approximately $1.5 million over 15 years (2002 year dollars). If all boat owners were required to convert to nontoxic paints immediately, costs to boaters would be approximately $33.8 million (Carson, et al., 2002).

F.4 Sediment Remediation and Cleanup

There are a number of limitations associated with estimates of unit costs for sediment remediation and cleanup. Unit costs are generally only applicable to the conditions and constraints of the site remediated (Myers, 2005). Factors such as project scale, beneficial use opportunities, and the need for land are highly site-specific and greatly influence project costs (Myers, 2005). Myers (2005) also points out that unit costs for a one time remediation job will generally be greater than unit costs of a long term project in which a specific amount of sediment is treated each year over many years, due to economies of scale.

The types of remedial or cleanup activities implemented and their effectiveness are also highly site-specific. For example, sediment capping may be feasible in a deep water area but not feasible in a shallower area through which large ships have to pass. Also, dredging may be cost-effective where only the top layer of sediment is contaminated. However, where contamination exists beneath the top layer of sediment, dredging may not be feasible or cost-effective. Thus, information on the extent of contamination and water body uses is important in determining feasible cleanup options.

Another limitation to most unit cost estimates is a lack of detail on how the costs were derived. Tetra Tech and Averett (1994) (as cited in Myers, 2005) estimate that unit costs for a thermal gas phase reduction process range from $426/cy to $506/cy. This estimate reflects the build up of costs in a number of categories, including site preparation, permitting, capital equipment, pretreatment, labor, consumables, supplies, and utilities, effluent treatment and disposal, monitoring, maintenance, site demobilization and cleanup, dredging, construction of and transportation to temporary storage facility, land leases, and disposal of residual material. However, due to site-specific conditions in another area (e.g., lack of available space to construct a temporary storage facility), these particular estimates may not be applicable. If documentation regarding the buildup of costs for each category is available, the estimates could potentially be modified to take site-specific conditions into account.

In 1997, the National Academy of Sciences (NAS) published comparison unit cost and cost-effectiveness information for a number of remediation strategies (**Exhibit F-5**). NAS (1997) ranked the alternatives based on feasibility, effectiveness, practicality, and cost (<$1/cy to $1,000/cy). The lowest cost option (natural recovery) does not rank high in feasibility or practicality. In comparison, the highest cost option (thermal ex situ treatment) ranks high in feasibility, effectiveness, and practicality.

Exhibit F-5. Cost-Effectiveness of Sediment Remediation Approaches

Approach	Feasibility	Effective	Practicality	Cost
Interim Control				
Administrative	0	4	2	4
Technological	1	3	1	3
In Situ Treatment				
Natural Recovery	0	4	1	4
Capping	2	3	3	3
Treatment	1	1	2	2
Sediment Removal and Transport	2	4	3	2
Ex Situ Treatment				
Physical	1	4	4	1
Chemical	1	2	4	1
Thermal	4	4	3	0
Biological	0	1	4	1
Ex Situ Containment	2	4	2	2

Scoring	Feasibility	Effective	Practicality	Cost
0	<90%	Concept	Not acceptable, very uncertain	$1,000/cy
1	90%	Bench		$100/cy
2	99%	Pilot		$10/cy
3	99.9%	Field		$1/cy
4	99.99%	Commercial	Acceptable, certain	<$1/cy

Source: SWRCB (1998), as adapted from and reprinted with permission from Contaminated Sediments in Ports and Waterways Cleanup Strategies and Technologies. Copyright 1997 by the National Academy of Sciences. Courtesy of the National Academy Press, Washington, D.C.

Comparable to the NAS estimates from 1997, USACE (2001) indicates that sediment treatment costs can range from around $50/cubic meter ($65/cy) for a process such as stabilization to over $1,000/cubic meter ($1,300/cy) for high temperature thermal processes. These estimates are based on project costs throughout the United States. However, preliminary estimates from USACE (1999) for capping sediments in the Palos Verdes Shelf in California range from $1.79/cy to $5.06/cy, which is greater than the $1/cy estimate in the exhibit.

As part of a cleanup and abatement order, the San Diego Regional Water Board developed unit cost estimates for dredging contaminated sediments in the San Diego Bay based on preliminary cost estimates from Exponent (2003). **Exhibit F-6** shows these unit costs. All of the estimates are for dredging with a mechanical dredge and do not include the sediment volume from areas beneath piers or within 10 feet of structures because of stability concerns.

Exhibit F-6. Dredging Unit Cost Estimates

Cleanup Alternative	Approximate Dredge Volume (cubic yards)	Approximate Total Cost	Approximate Cost per Cubic Yard
LAET	75,000	$15,000,000	$200
5x Background	754,000	$88,000,000	$117
Background	1,200,000	$120,000,000	$102

Sources: SDRQWCB (2007)
LAET = lowest apparent effects threshold

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