Draft Staff Report
Water Quality Control Plan for Enclosed Bays and Estuaries

Part 1. Sediment Quality

State Water Resources Control Board
California Environmental Protection Agency
July 18, 2008

Table of Contents

List of Abbreviations vii

1. INTRODUCTION 1

1.1 Purpose 1
1.2 Mandate to develop SQOs 1
1.3 Scientific Peer Review 2
1.4 Advisory and Scientific Committees 3
1.5 CEQA Analysis and Impact of the Proposed Policy 4
1.6 Compliance with cwc Sections 13241 and 13242 5
1.7 Authors and Contributors 5
1.8 Proposed Project and Description 5
1.9 Statement of Goals 6
1.10 Document Organization 7

2. CONCEPTUAL MODEL FOR SEDIMENT QUALITY 8

3. ENVIRONMENTAL SETTING 12

3.1 North Coast Region 13
3.2 San Francisco Bay Region 15
3.3 Central Coast Region 19
3.4 Los Angeles Region 21
3.5 Central Valley Region 26
3.6 Santa Ana Region 32
3.7 San Diego Region 34

4. REGULATORY BASELINE 39

4.1 Existing Water quality standards related to sediment quality 40
4.1.1 Applicable Basin Plan Narrative Objectives or Prohibitions 40
4.1.2 Current Regional Water Board Approaches for Assessing Whether Sediment Quality Complies with Applicable Standards 43
4.1.3 Toxic Pollutant Standards 45
4.2 Current Sediment Cleanup and Remediation Activities 46
4.2.1 Section 303(d) Activities 46
4.2.2 Cleanup and Abatement Actions 48
4.2.3 Bay Protection and Toxic Cleanup Program 49
4.2.4 Hazardous Waste Site Cleanups 55
4.3 Maintenance and Navigation Dredging 56
4.3.1 Clean Water Act Section 404/MPRSA 56
4.3.2 Water Quality Certifications 58
4.4 Point Sources Regulated under CLEAN WATER ACT §402 59
4.4.1 Storm Water 59
4.5 Nonpoint Source control 60
4.5.1 Agriculture 61
4.5.2 Forestry 64
4.5.3 Urban Runoff 65
4.5.4 Marina and Recreational Boating 66
4.5.5 Abandoned and Active Mines 67
4.5.6 Atmospheric Deposition 68

5. ISSUES AND ALTERNATIVES 69

5.1 Project Alternatives 69

5.1.1 No Project Alternative ... 69
5.1.2 What Issues should the draft Part 1 address ... 70
5.2 Applicable Waters and Sediment ... 70
5.2.1 Applicable Waters ... 70
5.2.2 Applicable Sediments ... 71
5.3 Beneficial Uses and Receptors ... 72
5.3.1 Beneficial uses potentially addressed in the draft Part 1 ... 72
5.3.2 Choice of receptors ... 74
5.4 Benthic communities exposed directly to pollutants within Enclosed Bays ... 76
5.4.1 Lines of Evidence ... 76
5.4.2 Form of Sediment Quality Objectives ... 80
5.4.3 Sediment Toxicity ... 80
5.4.4 Chemical Analysis ... 92
5.4.5 Benthic Community ... 98
5.4.6 Integration of Direct Effects LOE within embayments ... 102
5.5 Indicators applicable in estuarine habitats ... 107
5.5.1 Potential interim tools and methods for the Delta and other estuaries ... 107
5.5.2 Sunset date for interim tools ... 110
5.6 Protective Condition ... 110
5.7. Application of Proposed within Specific Programs ... 111
5.7.1 Applicability to Sediment Cleanup Actions ... 112
5.7.2 Applicability to dredged materials management ... 113
5.7.3 Applicability to 303(d) Listings ... 116
5.7.4 Applicability to NPDES Permits ... 118
5.7.4.3 Potential response actions for exceedances ... 120
6.0 ENVIRONMENTAL EFFECTS OF THE DRAFT PART 1 ... 122
6.1 Regulatory Requirements ... 122
6.2 Description of Analysis ... 122
6.3 Summary of Baseline Conditions ... 124
6.4 Incremental Impacts Above Baseline Conditions ... 125
6.5 Program Alternatives ... 126
6.6 Reasonably Foreseeable Methods of Compliance ... 127
6.7 Potential Adverse Environmental Effects ... 128
6.8 Growth-Inducing Impacts ... 129
6.9 Cumulative and Long-Term Impacts ... 129
6.10 Potential Environmental Impacts and Mitigation ... 130
6.11 MANDATORY FINDINGS OF SIGNIFICANCE ... 136
7. CWC SECTION 13241 AND ANTIDEGRADATION ... 137
7.1 Past, present, and probable future beneficial uses of water. ... 137
7.2 Environmental characteristics of the hydrographic unit under consideration, including the quality of water thereto. ... 137
7.3 Water quality conditions that could reasonably be achieved through the coordinated control of all the factors which affect water quality in the area ... 138
7.4 Economic Considerations. ... 138
7.5 The need for developing housing within the region. ... 143
7.6 The need to develop and use recycled water ... 144
7.7 Antidegradation ... 144
8.0 GLOSSARY ... 145
9.0 REFERENCES ... 151

APPENDICIES..164

List of Tables

Table 3.1. Summary of sediment quality related 303(d) listing of bays and estuaries in the San Francisco Region (SWRCB, 2006) 17
Table 3.2. 303(d) tissue listings in bays and estuaries of the San Francisco Region (SWRCB, 2006)..18
Table 3.3. 303(d) Water quality listings in bays and estuaries of the San Francisco Region (SWRCB, 2006)..18
Table 3.4 303(d) listings related to sediment quality in bays and estuaries of the Central Coast Region (SWRCB, 2006). 21
Table 3.5 303(d) listings related to water quality in bays and estuaries of the Central Coast Region (SWRCB, 2006). 21
Table 3.6. Summary of sediment quality related 303(d) listing of bays and estuaries in the Los Angeles Region (SWRCB, 2006) 24
Table 3.7. Summary of 303(d) tissue listings in bays and estuaries of the Los Angeles Region included (SWRCB, 2006) 25
Table 3.8. Summary of 303(d) water quality listings in bays and estuaries of the Los Angeles Region included (SWRCB, 2006)..25
Table 3.9. Summary of 303(d) tissue listings in estuaries of the Central Valley Region (SWRCB, 2006)..31
Table 3.10. Summary of 303(d) water quality listings in estuaries of the Central Valley Region (SWRCB, 2006)..31
Table 3.11. Summary of sediment quality related 303(d) listing of bays and estuaries in the Santa Ana Region (SWRCB, 2006) 34
Table 3.12. Summary of 303(d) tissue listing of bays and estuaries in the Santa Ana Region (SWRCB, 2006)..34
Table 3.13. Summary of 303(d) water quality listings for toxic pollutants in bays and estuaries of the Santa Ana Region (SWRCB, 2006) 34
Table 3.14. Summary of sediment quality related 303(d) listing of bays and estuaries in the San Diego Region (SWRCB, 2006) 37
Table 3.15. Summary of sediment quality related 303(d) tissue listing of bays and estuaries in the San Diego Region (SWRCB, 2006) 37
Table 3.16. Summary of water column related 303(d) listing for toxic pollutants in bays and estuaries of the San Diego Region (SWRCB, 2006) 38
Table 4.1. Toxic Hot Spot Ranking Criteria..51
Table 4.2. Enclosed Bays Listed as Known Toxic Hot Spots.................................52
Table 5.1 Beneficial Uses for Enclosed Bays and Estuaries..................................73
Table 5.2. List of candidate sediment toxicity tests, the citations containing testing protocols and whether quality assurance and test acceptability criteria have been established. 82
Table 5.3. Characteristics of candidate sediment toxicity test methods from Bay et al (2007a). NA=not applicable for test. 85
Table 5.4. Ratings of acute and sublethal sediment toxicity methods from Bay et al (2007a). Total score is sum of ratings..86
Table 5.5. Proposed toxicity threshold values for the sediment toxicity test methods 92
Table 5.6. Nonparametric Spearman correlation (r) and classification accuracy of statewide SQG approaches for amphipod mortality. 97

Table 5.7. Classification accuracy and Spearman correlation of regional SQG approaches for amphipod mortality. 97
Table 5.8. Classification accuracy of CSI and toxicity-based SQG approaches for benthic community condition. 97
Table 5.9. Classification accuracy and bias for indices and index combinations. 101
Table 5.10 Severity of effect classifications, derived from benthos and toxicity LOE. 104
Table 5.11. Potential that effects are chemically-mediated categories, derived from chemistry and toxicity LOE. 105
Table 5.12 Multiple lines of evidence station classifications. 106
Table 5.13. Summary of categorical assessments for each expert. 106
Table 5.14. Potential measures for LOE evaluation in estuaries. 109
Table 7.1 Incremental Impacts Associated with Part 1 139
Table 7.2. Potential Sampling Costs under the Plan 140
Table 7.3 Potential Incremental Sediment Quality Monitoring Costs 141

List of Figures

Figure 2.1. Principal sources, fates, and effects of sediment contaminants in enclosed bays and estuaries. Adapted from Brides et al. 2005. 11
Figure 2.2. Sediment processes affecting the distribution and form of contaminants. 11
Figure 3.2 San Francisco Bay Region 16
Figure 3.3 Central Coast Region 20
Figure 3.4 Los Angeles Region 23
Figure 3.5 Central Valley Region Sacramento Hydrologic Basin 28
Figure 3.7 Central Valley Region Tulare lake Hydrologic Basin 30
Figure 3.8 Santa Ana Region 33
Figure 3.9 San Diego Region 36
Figure 5.1 Conceptual approach and process for assigning the category of toxicity from laboratory test results. 91
Figure 5.2. Schematic of multiple lines of evidence (MLOE) integration framework. 104

Appendices

A Draft Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1 Sediment Quality
B Environmental Checklist
C. Direct Effects Station Assessment Example Calculation
D Toxic Hot Spots
E Comments and Responses

List of Abbreviations

AET	Apparent Effects Threshold
AVS	Acid Volatile Sulfides
BAT	best available technology economically achievable
BCT	best conventional pollutant control technology
BLM	U.S. Bureau of Land Management
BSAF	Biota-sediment bioaccumulation factor
BPTCP	Bay Protection and Toxic Cleanup Program
BRI	Benthic Response Index
CAA	Cleanup and Abatement Account
CAC	County Agricultural Commissioners
CAP	Corrective Action Plan
Cal/EPA	California Environmental Protection Agency
CCC	California Coastal Commission
CDF	California Department of Forestry
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CTR	California Toxics Rule
CWA	Federal Clean Water Act
CWC	California Water Code
DPR	Department of Pesticide Regulation (Cal/EPA)
DOC	Department of Conservation
DTSC	Department of Toxic Substances Control (Cal/EPA
EqP	Equilibrium Partitioning
ESA	Endangered Species Act
ESG	Equilibrium-Partitioning Sediment Guideline
EMAP	Environmental Monitoring and Assessment Program
ERL	Effects Range Low
ERM	Effects Range Median
FED	Functional Equivalent Document
GHG	Greenhouse Gas
ITM	Inland Testing Manual
LA CSTF	Los Angeles Contaminated Sediments Task Force
MEP	Maximum Extent Practical
MMs	Management Measures
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOA	Notice of Applicability
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NSI	National Sediment Inventory
OPA	Federal Oil Pollution Act
OTM	Ocean Testing Manual
PAHs	Polyaromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PEC	Probable effect concentration (consensus-based)
PEC-Q	Probable effect concentration quotient
PEL	Probable effect level

POTW	Publicly Owned Treatment Works
RCRA	Resource Conservation and Recovery Act
RWQCBs	Regional Water Quality Control Boards (CalEPA)
RMP	Regional Monitoring Program
SARA	Superfund Amendments and Reauthorization Act
SCCWRP	Southern California Coastal Water Research Project
SEM	Simultaneously Extracted Metals
SIP	Policy for the Implementation of Toxic Standards for Inland Surface Waters
SMARA	Surface Mining and Reclamation Act
SQG	Sediment Quality Guidelines
SQO	Sediment Quality Objective
SSC	Scientific Steering Committee
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board (Cal/EPA)
THP	Timber Harvest Plan
TIE	Toxicity Identification Evaluation
TMDL	Total Maximum Daily Load
TMDL	Total Maximum Daily Loads
TOC	Total Organic Carbon
TRA	Tissue Residue Approach
TRG	Tissue residue guideline
TRV	Toxicity reference values
TVS	Total Volatile Sulfides
USACE	U.S Army Corps of Engineers
U.S. EPA	U.S. Environmental Protection Agency
USFS	U.S. Forestry Service
USF&WS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
WDR	Water Discharge Requirements

1. INTRODUCTION

1.1 PURPOSE

This report represents the State Water Resources Control Board (State Water Board) formal water quality planning and substitute environmental document for the adoption of sediment quality objectives (SQOs) and program of implementation that would apply to enclosed bays and estuaries of California. The title of the proposed plan where the SQOs and policy of implementation would reside is *Water Quality Control Plan for Enclosed Bays and Estuaries of California, Part 1 Sediment Quality* (Part 1). SQOs would provide the State and Regional Water Quality Control Boards stakeholders and interested parties with a technically robust mechanism to differentiate sediments impacted by toxic pollutants from those that are not consistently through out the coastal regions. The proposed SQOs developed through this program do not address excessive sediment loading (siltation or sedimentation) related impairment or degradation.

Sediments in enclosed bays and estuaries are, with few exceptions, the most highly polluted sediments in the State. Historically, areas adjacent to bays and estuaries were the first heavily industrialized regions in the State; and, as a result, wastes have been discharged into bays either directly as point sources, indirectly as runoff, or accidentally through releases and spills for many years. Sediment carried down rivers and creeks also contributes to the contaminant loading into bays and estuaries. Many contaminants, such as metals and pesticides, readily attach to the sediments. Through this mechanism, contaminants from inland sources can be transported long distances. Poor flushing and low current speeds allow the sediments and contaminants to settle out in the bays and estuaries before reaching the open ocean. Few states have attempted to develop SQOs due to the lack of ecologically relevant tools, difficulties interpreting and integrating the results, and an inability to establish causality. In 2003, the State Water Board initiated a program to protect these water bodies through the development of SQOs for enclosed bays and estuaries.

1.2 MANDATE TO DEVELOP SQOS

In 1989, the Legislature added chapter 5.6 to Division 7 of the California Water Code. The legislation required the State Water Board to develop sediment quality objectives as part of a comprehensive program to protect beneficial uses in enclosed bays and estuaries. The objectives are required "for toxic pollutants" that were identified in toxic hot spots or that were identified as pollutants of concern by the State Water Board or the Regional Water Quality Control Boards (Regional Water Boards).[1] The waters targeted for protection are enclosed bays and estuaries.

The Legislature defined a "sediment quality objective" (SQO) as "that level of a constituent in sediment which is established with an adequate margin of safety, for the reasonable protection of the beneficial uses of water or the prevention of nuisance."[2] The SQOs have to "be based on scientific information, including, but not limited to, chemical monitoring, bioassays, or established modeling procedures."[3] They must

[1] See Wat. Code sec. 13392.6.
[2] *Id.* sec. 13391.5.
[3] *Id.* sec. 13393.

"provide adequate protection for the most sensitive aquatic organisms."[4] The State Water Board is not precluded from adopting SQOs for a pollutant even though additional research may be needed.[5]

In addition, if there is a potential for human exposure to pollutants through the food chain, the State Water Board must base SQOs on a health risk assessment.[6] A health risk assessment is an analysis that evaluates and quantifies the potential human exposure to a pollutant that bioaccumulates in edible fish, shellfish, or wildlife.[7] A health risk assessment "includes an analysis of both individual and population wide health risks associated with anticipated levels of human exposure, including potential synergistic effects of toxic pollutants and impacts on sensitive populations."[8]

The Legislature required the State Water Board to develop a workplan by July 1991 for the adoption of SQOs and to adopt the SQOs pursuant to the workplan.[9] In 1991, the State Water Board developed a seven year conceptual approach, which is described in the Workplan for the Development of Sediment Quality Objectives for Enclosed Bays and Estuaries of California (91-14 WQ) (1991 Workplan).

This 1991 Workplan 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. This conceptual approach embodied in the workplan was never implemented because available resources were primarily focused on identifying toxic hot spots using multiple lines of evidence.

In 1999, a lawsuit was filed against the State Water Board for failing, among other things, to adopt SQOs. The Court sided with the petitioners and ordered the State Water Board to develop SQOs and implementation measures. The Court also required the State Water Board to prepare a revised workplan. The draft revised workplan was circulated for public comment and adopted by the State Water Board on May 21, 2003. The targeted receptors, proposed objectives and indicators described in this staff report are based upon the technical elements described in that workplan.

1.3 SCIENTIFIC PEER REVIEW

In 1997, Section 57004 was added to the California Health and Safety Code. Section 57004 requires external scientific peer review of the scientific basis for any rule proposed by any board, office, or department within California Environmental Protection Agency (Cal/EPA). Scientific peer review ensures that public resources are managed effectively. Scientific peer review was requested through a contract with the University of California at Berkeley in November 2008. The following scientists agreed to review the technical issues associated with the draft staff report and Part 1.

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[4] *Ibid.*
[5] See *id.* sec. 13392.6.
[6] *Id.* sec. 13393.
[7] *Id.* sec. 13391.5(c).
[8] *Ibid.*
[9] *Id.* secs. 13392.6, 13393.

Dr. Dominic Di Toro, Edward C. Davis Professor of Civil and Environmental Engineering Department of Civil and Environmental Engineering, University of Delaware

Dr. John P. Knezovich, PhD, Director, Center for Accelerator Mass Spectrometry, L-397 Lawrence Livermore National Laboratory

Dr. Linda C. Schaffner, Professor Department of Biological Sciences, School of Marine Science Virginia Institute of Marine Science The College of William and Mary

Dr. David L. Sedlak, Professor, Environmental Engineering Program Department of Civil and Environmental Engineering, University of California at Berkeley

Peer reviews are posted at http://www.waterboards.ca.gov/bptcp/sediment.html. Responses to peer review comments are presented as Appendix XXX

1.4 ADVISORY AND SCIENTIFIC COMMITTEES

Advisory Committees

The 1989 amendments to the Water Code required the State Water Board to form an advisory committee to assist in the implementation of chapter 5.6. State Water Board staff invited stakeholders and interested parties to participate in this committee, which was intended to focus on SQOs development and implementation within bays. The organizational meeting for this committee was held on July 29, 2003. A second advisory committee was formed on April 13, 2006 to advise the State Water Board on issues associated with the development and implementation of SQOs within the Sacramento-San Joaquin Delta and other estuarine waters in the State. Dr. Brock Bernstein serves as Chairperson and facilitator on both committees.

Scientific Steering Committee

The Scientific Steering Committee (SSC) was formed for the purpose of independently assessing the soundness and adequacy of the technical approach and ensuring that all findings and conclusions are well supported. The SSC provided the State Water Board's technical team with a very high level of expertise and experience from around the nation. The members on this committee are:

- Dr. Peter Landrum, Committee Chair: Research Chemist NOAA/Great Lakes Environmental Research Laboratory Ann Arbor, MI
- Ed Long; Former NOAA Scientist and developer of empirically derived sediment quality guidelines for NOAA's Status and Trends Program.
- Tom Gries; Environmental Scientist Washington Dept. of Ecology, Sediment Management Section, Olympia, WA
- Dr. Todd Bridges Research Biologist and Director of the Center for Contaminated Sediments, Waterways Experiment Station (WES) U.S. Army Corps of Engineers, ERDC, Vicksburg, MS
- Dr. Robert F. Van Dolah; Benthic Ecologist and Director of the South Carolina Marine Resources Research Institute.
- Dr. Robert Burgess Research Scientist, EPA's Office of Research and Development (Atlantic Ecology Division-Narragansett)

Agency Coordination Committee

The Agency Coordination Committee is an informal committee composed of staff from agencies that assess, regulate or manage contaminated sediments. Participants include staff from the coastal Regional Water Boards, Department of Toxic Substances Control, Department of Fish and Game, U.S EPA, and U.S Fish and Wildlife Service. The role of this committee was to assist Water Board staff in the integration of other programs and policies related to sediment quality and identify potential areas of conflict.

1.5 CEQA ANALYSIS AND IMPACT OF THE PROPOSED POLICY

When developing water quality objectives and water quality control plans, the State Water Board must comply with the California Environmental Quality Act (CEQA), Public Resources Code §21000 et seq. The objectives of CEQA are to: 1) inform the decision makers and public about the potential significant environmental effects of a proposed project, 2) identify ways that environmental damage may be mitigated, 3) prevent significant, avoidable damage to the environment by requiring changes in projects, through the use of alternatives or mitigation measures when feasible, and 4) disclose to the public why an agency approved a project if significant effects are involved. (Cal. Code Regs., tit. 14, § 15002(a).)

Although state agencies are subject to the environmental impact assessment requirements of CEQA, CEQA authorizes the Secretary of the Resources Agency to exempt specific state regulatory programs from the requirements to prepare Environmental Impact Reports (EIRs), Negative Declarations, and Initial Studies, if certain conditions are met (Public Resources Code, §21080.5). The water quality control (basin)/208 planning program of the State Water Board has been certified by the Secretary for Resources as meeting the requirements for exemption (California Code of Regulations (CCR), title 14, §15251(g)). Agencies qualifying for this exemption must comply with CEQA's goals and policies; evaluate environmental impacts; consider cumulative impacts; consult with other agencies with jurisdiction; provide public notice and allow public review; respond to comments on the draft environmental document; adopt CEQA findings; and provide for monitoring of mitigation measures. State Water Board regulations (CCR, tit. 23, §3777) require that a document prepared under its certified regulatory programs include:

- A brief description of the proposed project;
- Reasonable alternatives to the proposed project; and
- Mitigation measures to minimize any significant adverse environmental impacts of the proposed activity.

Accordingly, the State Water Board prepares programmatic substitute environmental documents (SEDs) in lieu of EIRs or other environmental documents when proposing statewide water quality objectives and a program of implementation. This Staff Report fulfills these requirements of a substitute environmental document. Until recently, the State Water Board referred to these formal planning documents as functional equivalent documents. There is no substantive difference between these documents.

Responses to comments and consequent revisions to the information in the Draft Staff Report are subsequently presented in a draft Final Staff Report for consideration by the State Water Board. After the State Water Board has certified the document as adequate, the title of the document becomes the Final Staff Report.

1.6 COMPLIANCE WITH CWC SECTIONS 13241 AND 13242

Chapter 5.6 requires that the State Water Board adopt sediment quality objectives in accordance with the procedures proscribed in the Water Code for adopting and amending water quality control plans. The procedures include notice and a public hearing prior to plan adoption. In addition, Section 13241 of the Water Code requires that the Water Boards consider specified factors when they establish water quality objectives to ensure the reasonable protection of beneficial uses. These factors include:
(a) Past, present, and probable future beneficial uses of water.
(b) Environmental characteristics of the hydrographic unit under consideration.
(c) Water quality conditions that could reasonably be achieved through control of all factors affecting water quality.
(d) Economic considerations.
(e) The need for developing housing within the region.
(f) The need to develop and use recycled water.

Water Code section 13242 requires that the Water Boards formulate a program of implementation for the water quality objective under consideration by the Board. The program of implementation for achieving water quality objectives must include, at least:
(a) A description of the nature of actions that is necessary to achieve the objectives, including recommendations for appropriate action by any entity, public or private.
(b) A time schedule for the actions to be taken.
(c) A description of surveillance to be undertaken to determine compliance with objectives

1.7 AUTHORS AND CONTRIBUTORS

Mr. Chris Beegan from the Division of Water Quality - Ocean Unit prepared this draft staff report and draft Part 1. Principal Scientist Mr. Steve Bay, Mr. Ana Ranasinghe, Dr. Kerry Ritter, Dr. Art Barnett and Dr. Steve Weisberg with the Southern California Coastal Water Research Project provided the technical analysis and studies in support of the proposed SQP. Drs. Mike Connor and Bruce Thompson and Mr. Ben Greenfield at San Francisco Estuary Institute also contributed technical analysis and studies for this program. Mr. Dominic Gregorio and Mr. Craig J. Wilson from the Division of Water Quality and Ms. Sheila Vassey from the Office of Chief Counsel provided valuable input during the preparation of this document. Ms. Eloise Castillo and Ms Lauren Praesel from Science Application International Corporation (SAIC) prepared the economic analysis of the Draft Part 1.

1.8 PROPOSED PROJECT AND DESCRIPTION

The State Water Board is proposing the following project: the adoption of a Water Quality Control Plan for Enclosed Bays and Estuaries of California, Part I Sediment Quality (Part 1)." The draft Part 1 contains narrative SQOs indicators and threshold used to interpret the narrative objectives and a program of implementation. The draft Part 1 if adopted would be applicable to all enclosed bays and estuaries of California.

Enclosed bays are defined in Water Code section 13391.5 as:

> *indentations along the coast which enclose an area of oceanic water within distinct headlands or harbor works. Enclosed bays include all bays where the*

narrowest distance between headlands or outermost harbor works is less than 75 percent of the greatest dimension of the enclosed portion of the bay. This definition includes, but is not limited to: Humboldt Bay, Bodega Harbor, Tomales Bay, Drakes Estero, San Francisco Bay, Morro Bay, Los Angeles Harbor, Upper and Lower Newport Bay, Mission Bay, and San Diego Bay.

This section defines estuaries as:

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

If adopted, the regulatory provisions of the draft Part 1 would be enforced by the State Water Board and coastal Regional Water Boards, consisting of the North Coast, San Francisco Bay, Central Coast, Los Angeles, Central Valley, Santa Ana and San Diego Regional Water Boards.

Those regulated under the proposed draft Part 1 would include individual or organization that discharges toxic pollutants to enclosed bays and estuaries of California or rivers or streams draining into enclosed bays and estuaries.

1.9 STATEMENT OF GOALS

The Water Code defines a sediment quality objective as that level of a constituent in sediment established with an adequate margin of safety for the reasonable protection of beneficial uses or prevention of nuisances. The Water Code does not define the term “reasonable”; however, the American Heritage Dictionary defines the term as governed by or in accordance with reason or sound thinking, within the bounds of common sense, not excessive or extreme; fair moderate (American Heritage Dictionary of English Language, New College Edition 1976).

The objective of this program since 2002 has been to develop SQOs and robust indicators in conjunction with a program of implementation that protects two beneficial uses, aquatic life and human health. The goals of this program are to:

- Establish narrative receptor-specific SQOs.
- Establish a condition that is considered protective for each targeted receptor.
- Identify appropriate lines of evidence for each receptor that when integrated can support a confident interpretation of the narrative objective.
- Develop and/or refine and validate specific indicators for each line of evidence so that the condition of each station can be measured relative to the protected condition.
- Build a program of implementation based upon these tools and the current level of scientific understanding to promote the protection of sediment quality related beneficial uses.

- Define a process that will result in better management and more effective restoration of polluted sediments

Staff believes the approach developed to assess aquatic life via benthic communities for Southern California's enclosed bays and marine lagoons and polyhaline San Francisco Bay has met these goals. For other bays on the central and north coast such as Morro Bay, Humboldt Bay, Tomales Bay, and all estuaries including the Sacramento-San Joaquin Delta, the lack of available data prevented the staff and technical team from achieving these goals. In response, State Water Board staff have proposed a less robust means to determine if sediment quality is meeting the narrative aquatic life - benthic community SQO in these waters. However, State Water Board staff believe that work conducted in the next phase will provide superior indicators, which could replace these tools if adopted and be comparable to those developed for Southern California Bay and polyhaline San Francisco Bay in Phase II of the SQO program.

Although extensive progress was also made on developing an approach to interpret the human health-based narrative objective, Staff are proposing in this first phase to use existing site-specific human health risk methodology to interpret the narrative. As State Water Board staff stated in the May 2003 Workplan, developing sediment quality objectives that protect human health from consumption of contaminated fish is extremely complex for several reasons.

- The fate and transport of pollutants from sediment to tissue and the water column pollutants is highly site specific.
- Indirect exposure to pollutants from sediments transported up the food web is difficult to relate directly to specific sites or stations of area of a waterbody.
- The home range, habitat, feeding strategies, and lipid content of each fish species may vary seasonally and as the fish matures, all of which affects the rate of contaminant accumulation in the tissue.
- The type and size of prey-fish targeted by sport-fisherman and subsistence fisherman also varies considerably as do the methods of preparation, types of tissue consumed and consumption rates.

A more detailed approach to support the human health based SQOs will require greater time and effort. Staff expects this effort to be completed in the next phase, which would trigger a new proposed methodology for State Water Board consideration.

1.10 DOCUMENT ORGANIZATION

This document is organized as follows. A conceptual model describing the fate and transport of pollutants in sediments, potentially affected receptors and exposure mechanisms is described in Section 2. Section 3 describes the environmental setting of the coastal and estuarine Regional Water Board basins. The regulatory baseline is described in Section 4. Issues and Alternatives evaluated during the formulation of the draft Part 1 are discussed in Section 5. Section 6 describes the CEQA analysis and Water Code section 13241 factors. The Draft Part 1 is presented in Appendix A. The CEQA Checklist is included in Appendix B. Appendix C presents the application of a data set assessed by applying the indicators and appropriate thresholds included in the Draft Part 1. Summary Maps of Toxic Hot Spots are presented by Region in Appendix D. Comments on the draft staff report received by the State Water Board and staff's responses are presented in Appendix E.

2. CONCEPTUAL MODEL FOR SEDIMENT QUALITY

Sediment is a complex and dynamic environment, which can influence the fate and effects of the contaminants it contains. Sediment particles can vary from coarse sand with a diameter of about 1 millimeter (mm) to fine silts and clays with diameters less than 0.01 mm. Variations in the size and composition of these particles have an effect on the binding of contaminants to them, with the finer particles generally containing higher contaminant concentrations due to a much greater surface area and greater number of chemical sorption sites.

The assessment of sediment quality in bays and estuaries relies on information regarding the sources, fates and effects of contaminants of concern. The types of sources determine the overall magnitude, and spatial and temporal patterns of contaminant input to these nearshore environments. Contaminants in the receiving water environment are influenced by many processes that ultimately determine the type and amount of contaminant exposure to organisms. There are many gaps in our knowledge of contaminant sources and fate. Consequently, measurement of biological effects is often needed to determine the ecological significance of chemical measurements.

Multiple sources contribute to sediment contamination in embayments (Figure 2.1). Runoff and discharge from rivers, creeks, and drainage channels that carry storm water and dry weather runoff from the upland watershed are major nonpoint contaminant sources. Contaminants may also come from point source discharges, such as municipal wastewater and industrial discharges that are located within embayments, as well as spills. Additional nonpoint contaminant sources include atmospheric deposition and groundwater. A large portion of the contaminants from most of these sources may be associated with particles, either as suspended particles in the discharge or receiving water body. However, each of these discharges influences water and sediment quality on different spatial and temporal scales. This diversity of sources, combined with various physical mixing processes such as currents, tidal exchange, and ship traffic, can produce complex and widespread patterns of sediment contamination.

There are a number of processes occurring in embayments that affect the fate and distribution of sediment contaminants (Figure 2.1). Upon introduction into the water body, dissolved contaminants in the source may bind to suspended particles in the water column or particle associated contaminants may desorb back into the water column. In brackish embayments in particular, flocculation and aggregation of small-suspended particles into large agglomerates that then settle out of the water column is a primary mechanism for introduction of contaminants to surface sediments. Where river or tidal currents are present, some contaminants will be transported (advected) out of the system. The fraction that remains and eventually settles forms the sediment's surface, a layer (5-20 centimeters (cm)) of high physical, chemical, and biological activity. Most of the benthic infauna resides in this surface layer. The layer of sediment below is less active and contaminants that are contained in this layer generally exert little influence on organisms. However, contaminants in the deep sediment layer can affect habitat quality if they are transported to the surface by deep burrowing organisms, transformed into different chemical species under anaerobic conditions, or resuspended by physical processes such as sediment erosion or dredging.

Sediment contaminants in the surface layer are not static, their concentration, distribution, and chemical form are being continually modified. For example, particle bound contaminants can move into the water column by diffusion (desorption from particles), resuspension, or from the burrowing and feeding activities of many benthic organisms (bioturbation).

The form and biological availability of contaminants is influenced by many factors in the sediment. The sediment particles contain variable amounts and types of organic carbon, including natural plant or animal detritus, microbial films, and anthropogenic materials such as ash, soot, wood chips, oils, and tars. The partitioning of many contaminants between sediment particles, water, and biota is strongly influenced by the nature of sediment organic carbon (Figure 2.2). The predominant forms for metals (or speciation) are largely governed by the reduction-oxidation (redox) potential (or E_h) and the co-occurrence of binding constituents such as sulfides, organic material, metal oxides, and clay minerals. Although the general mechanisms affecting partitioning and speciation of contaminants are known, it is often difficult to predict such changes from chemical measurements with sufficient accuracy to determine their bioavailability, which in turn is key for assessing biological effects.

Microbial activities also influence the characteristics of sediment contaminants. The microbial degradation of sediment organic matter can alter the pH and oxygen content of sediments, which may in turn affect the rates of metal desorption/precipitation. Bacterial metabolism or chemical processes can also transform or degrade some contaminants to other forms. In some cases, the transformation product may have greater biological availability or toxicity, such as methyl mercury. In other cases, such as for some pesticides, degradation may alter the contaminant so that it is no longer toxic.

California's bays and estuaries are home to a tremendous diversity of life. As such, there are multiple routes by which these organisms can be exposed to and affected by sediment contaminants. There are two general types of contaminant exposure: direct and indirect. Most of the direct exposure results from the contact of organisms with the sediment and sediment ingestion. Organisms living in the sediment are exposed through the uptake of contaminants from the pore water, which is the water associated with the sediment particles. This process is analogous to the exposure of water column organisms from dissolved contaminants. Organisms that ingest sediments may accumulate contaminants that are desorbed by digestive processes in the gut. Indirect contaminant exposure results from the consumption of contaminated prey. Examples include fish feeding on benthic invertebrates, birds feeding on benthic invertebrates or fish, and humans consuming fish (Figure 2.1).

Benthic organisms are generally at greatest risk for adverse effects from direct sediment contaminant exposure, because these organisms often live in continual direct contact with sediment/pore water, and many species ingest significant quantities of sediment as a source of nutrition. The relative importance of sediment ingestion vs. sediment contact for contaminant exposure varies depending upon the life history of the species. In addition, there are species-specific differences in contaminant uptake rates and metabolism that affect the amount of contaminant (or dose) accumulated by benthic organisms. As a result, benthic species vary in their sensitivity to sediment contamination. This in turn produces a gradation of benthic community composition change that corresponds to the magnitude of contaminant exposure.

A variety of biological methods are needed to assess the direct effects of sediment contamination. Measurement of changes in the benthic community, such as abundance and species composition, are a sensitive measure of the direct effects of sediment contamination because these organisms live in the surface sediment layer. However, variations in sediment composition complicate this assessment because benthic organisms often have specific preferences or tolerances for variations in sediment grain size and organic content, in addition to other environmental factors such as water depth, salinity, and temperature. Consequently, the benthic community present at a site may be altered by a variety of environmental factors in addition to adverse effects from contaminants. It is necessary to understand how these environmental factors affect benthic communities before the effects of contaminants can be discerned.

Laboratory toxicity tests are also useful for assessing the direct effects of sediment. These tests measure the lethal or sublethal response of a test species exposed to the sediment under controlled conditions. Toxicity tests provide a measure of the bioavailability and toxicity of sediment contaminants from direct exposure and are not affected by many of the environmental factors that confound benthic community analyses or other measurements of effect in the field.

The magnitude of indirect contaminant exposure is affected by several key factors: biomagnification potential, feeding rate, and trophic level. Some contaminants, such as PCBs and methyl mercury, have an affinity for tissue lipids and tend to be retained and biomagnified in organisms. The tissue concentration of such contaminants often increases at higher trophic levels, such as fish-eating birds and mammals. The indirect exposure to some contaminants, such as inorganic forms of metals, may be relatively more significant for species that feed directly on benthic organisms, where the tissue concentrations are higher.

Feeding rate and movement also affect the amount of indirect exposure to contaminants. Unlike benthic organisms, fish, birds and mammals are often highly mobile and may spend a substantial portion of their lives away from the area of sediment contamination. Consequently, it is often difficult to determine the amount of contaminant exposure in these organisms that is due to feeding in the area of interest. Assessing the amount of indirect exposure resulting from sediment contamination is much more difficult than for direct exposure, as all of the complexities associated with the effects of sediment processes on contaminant exposure are compounded by additional variations in feeding and life history.

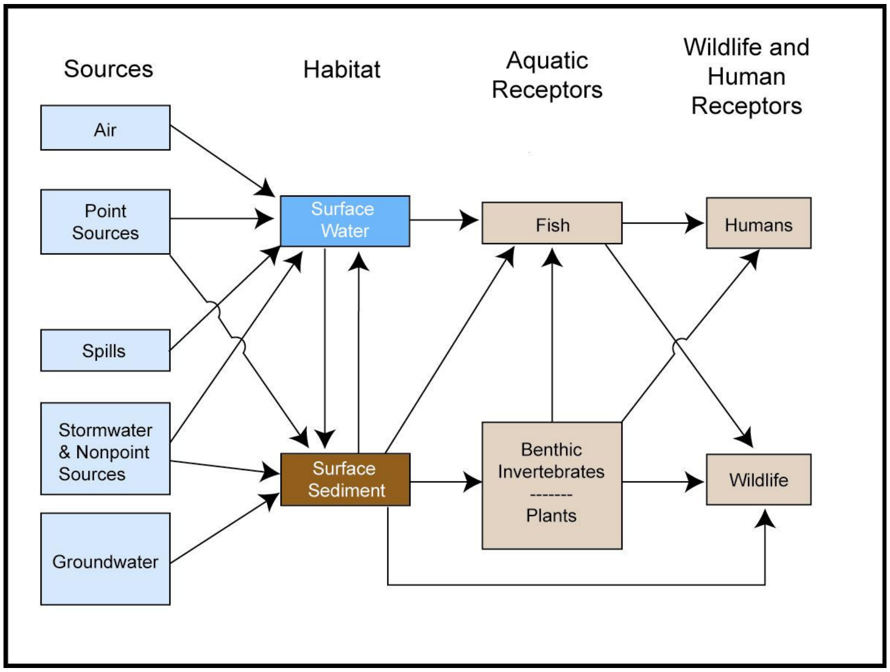


Figure 2.1. Principal sources, fates, and effects of sediment contaminants in enclosed bays and estuaries. Adapted from Brides et al. 2005.

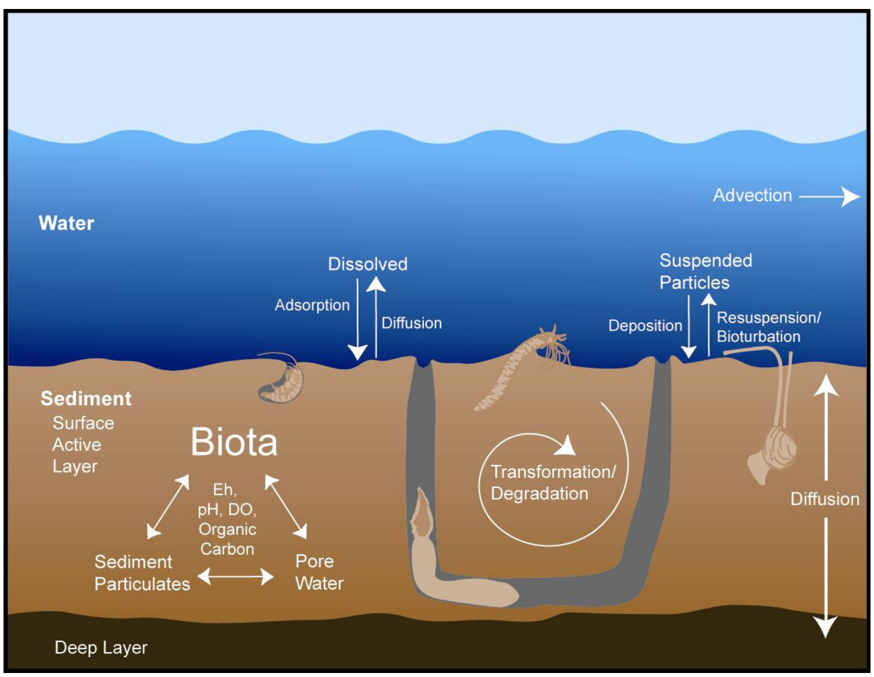


Figure 2.2. Sediment processes affecting the distribution and form of contaminants.

3. ENVIRONMENTAL SETTING

California encompasses a variety of environmental conditions ranging from the Sierra Nevada to deserts (with a huge variation in between these two extremes) to the Pacific Ocean. Specific geographical features that form basins, the availability of natural resources coupled with climate and topography have created a very broad range of land use patterns and population densities throughout California. Because of these unique differences around the State, the Legislature in the Porter-Cologne Water Quality Control Act, Water Code section 13000 et seq. (Porter-Cologne) divided the State into nine different hydrologic regions or basins. These regions consist of the North Coast , San Francisco Bay, Central Coast, Los Angeles, Central Valley, Lahontan, Colorado River, Santa Ana and San Diego Regions. Though many regions share some common environmental problems, each of the regions has a unique suite of factors, such as types of discharges, pollutants, potential risks to beneficial uses and receptors that are specific to that region.

The following section provides a brief description of the regions and waters within the regions. For each region, the section includes a summary of bays and estuaries within the region that have been listed on the State Water Board's 2006 Clean Water Act section 303(d) list for impairments related to sediment quality. The listings described below include water column, tissue and sediment quality impacts associated with toxic pollutants identified on the 2006 Section 303(d) list. Tissue listings are discussed because the food web exposure pathway frequently begins in the sediment. Water column listings are also included because the toxic pollutants eventually settle out and are deposited in the surface sediments. Many of these sediment- and tissue-related listings were designated previously by the State Water Board as Toxic Hot Spots and proposed for cleanup. Toxic Hotspots are identified in Table 4.2. Maps of hot spots are presented by Region in Appendix D.

The Lahontan and Colorado River Regions do not include enclosed bays[10] and estuaries[11] and are not considered further in this document. Descriptions of the regions were obtained from the individual water quality control plans (basin plans).

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

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

3.1 NORTH COAST REGION

The North Coast Region comprises all regional basins, including Lower Klamath Lake and Lost River Basins, draining into the Pacific Ocean from the California-Oregon state line southern boundary and includes the watershed of the Estero de San Antonio and Stemple Creek in Marin and Sonoma Counties (Figure 3.1). Two natural drainage basins, the Klamath River Basin and the North Coastal Basin, divide the Region. The Region covers all of Del Norte, Humboldt, Trinity, and Mendocino Counties, major portions of Siskiyou and Sonoma Counties, and small portions of Glenn, Lake, and Marin Counties. It encompasses a total area of approximately 19,390 square miles, including 340 miles of coastline and remote wilderness areas, as well as urbanized and agricultural areas.

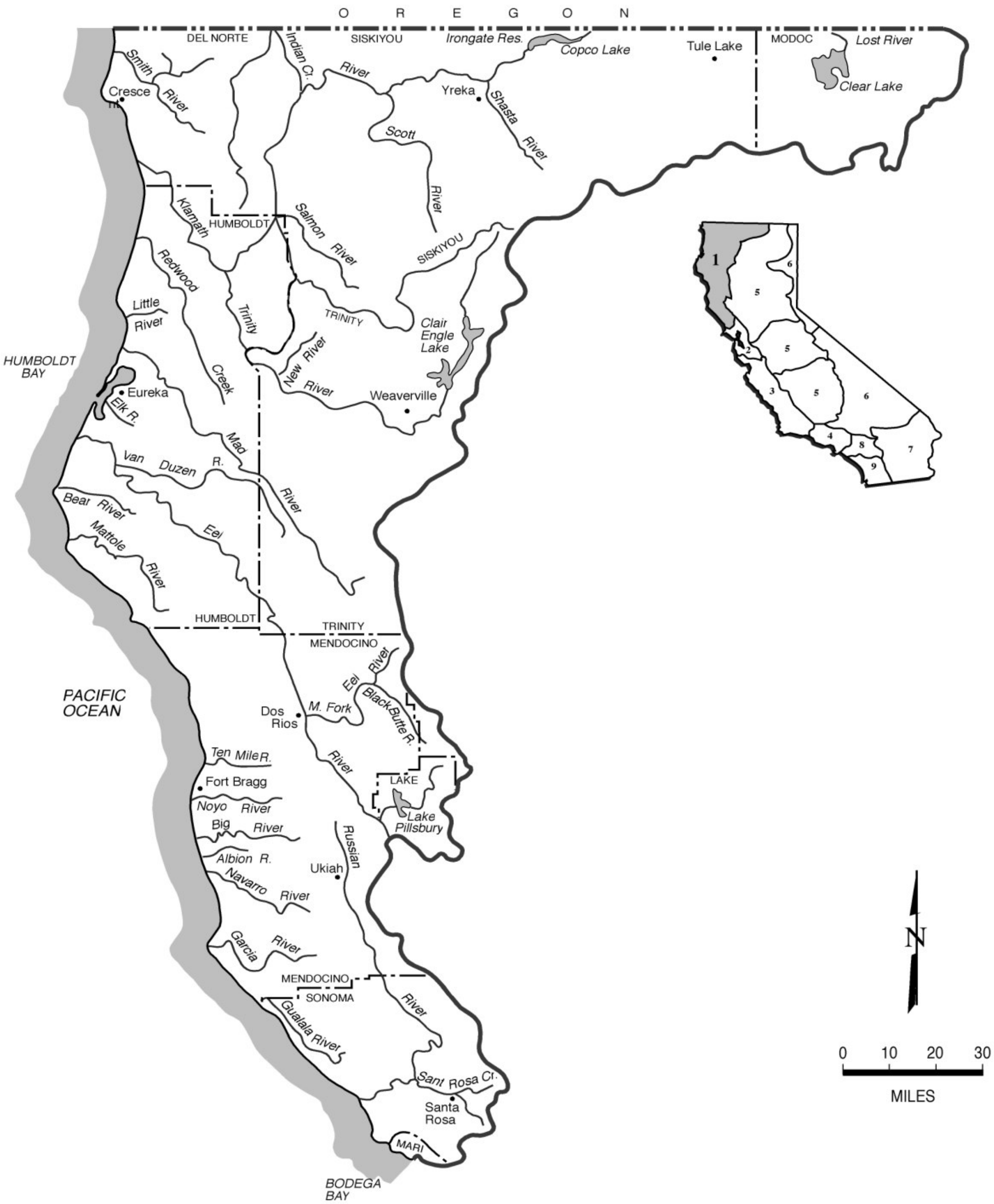
Beginning at the Smith River in northern Del Norte County and heading south to the Estero de San Antonio in northern Marin County, the Region encompasses a large number of major river estuaries. Other North Coast streams and rivers with significant estuaries include the Klamath River, Redwood Creek, Little River, Mad River, Eel River, Noyo River, Navarro River, Elk Creek, Gualala River, Russian River, and Salmon Creek (this creek mouth also forms a lagoon). Northern Humboldt County coastal lagoons include Big Lagoon and Stone Lagoon. The largest enclosed bay in the North Coast Region is Humboldt Bay in Humboldt County. Another enclosed bay, Bodega Bay, is located in Sonoma County near the southern border of the Region.

Distinct temperature zones characterize the North Coast Region. Along the coast, the climate is moderate and foggy with limited temperature variation. Inland, however, seasonal temperature ranges in excess of 100°F (Fahrenheit) have been recorded. Precipitation is greater than for any other part of California, and damaging floods are a fairly frequent hazard. Particularly devastating floods occurred in the North Coast area in December 1955, December 1964, and February 1986. Ample precipitation in combination with the mild climate found over most of the North Coast Region has provided a wealth of fish, wildlife, and scenic resources. The mountainous nature of the Region, with its dense coniferous forests interspersed with grassy or chaparral covered slopes, provides shelter and food for deer, elk, bear, mountain lion, fur bearers, and many upland bird and mammal species. The numerous streams and rivers of the Region contain anadromous fish, and the reservoirs, although few in number support both cold water and warm water fish.

Tidelands and marshes are extremely important to many species of waterfowl and shore birds, both for feeding and nesting. Cultivated land and pasturelands also provide supplemental food for many birds, including small pheasant populations. Tideland areas along the north coast provide important habitat for marine invertebrates and nursery areas for forage fish, game fish, and crustaceans. Offshore coastal rocks are used by many species of seabirds as nesting areas.

Major components of the economy are tourism and recreation, logging and timber milling, aggregate mining, commercial and sport fisheries, sheep, beef and dairy production, and vineyards and wineries. In all, the North Coast Region offers a beautiful natural environment with opportunities for scientific study and research, recreation, sport, and commerce.

North Coast Region (1)
NORTH COAST HYDROLOGIC BASIN PLANNING AREA (NC)



Base map prepared by the Division of Water Rights, Graphics Services Unit

Figure 3.1 North Coast Region

Approximately two percent of California's total population resides in the North Coast Region. The largest urban centers are Eureka in Humboldt County and Santa Rosa in Sonoma County. The most common factors affecting beneficial uses in the North Coast Region are temperature, nutrients and sedimentation in creeks and rivers that drain the region. Few toxic pollutants have been identified at levels causing degradation of beneficial uses in the bays and estuaries of the North Coast Region. Humboldt Bay was added to the 2006 303(d) List by the State Water Board due to dioxin compounds reported in fish tissue caught from that bay. Although some lakes are impaired do to mercury, there are no other toxic pollutant-related listings in bays and estuaries in this Region.

3.2 SAN FRANCISCO BAY REGION

The San Francisco Bay Region comprises San Francisco Bay, Suisun Bay beginning at the Sacramento River, and San Joaquin River westerly, from a line which passes between Collinsville and Montezuma Island (Figure 3.2). The Region's boundary follows the borders common to Sacramento and Solano Counties and Sacramento and Contra Costa Counties west of the Markely Canyon watershed in Contra Costa County. All basins west of the boundary, described above, and all basins draining into the Pacific Ocean between the southern boundary of the North Coast Region and the southern boundary of the watershed of Pescadero Creek in San Mateo and Santa Cruz Counties are included in the Region.

The Region comprises most of the San Francisco Estuary to the mouth of the Sacramento-San Joaquin Delta. The San Francisco Estuary conveys the waters of the Sacramento and San Joaquin Rivers to the Pacific Ocean. Located on the central coast of California, the Bay system functions as the only drainage outlet for waters of the Central Valley. It also marks a natural topographic separation between the northern and southern coastal mountain ranges. The Region's waterways, wetlands, and bays form the centerpiece of the fourth largest metropolitan area in the United States, including all or major portions of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma Counties.

The San Francisco Bay Regional Water Board has jurisdiction over the part of the San Francisco Estuary, which includes all of the San Francisco Bay segments extending east to the Delta (Winter Island near Pittsburg). The San Francisco Estuary sustains a highly dynamic and complex environment. Within each section of the Bay system lie deepwater areas that are adjacent to large expanses of very shallow water. Salinity levels range from hypersaline to fresh water and water temperature varies widely.

The Bay system's deepwater channels, tidelands, marshlands, fresh water streams and rivers provide a wide variety of habitats within the Region. Coastal embayments including Tomales Bay and Bolinas Lagoon are also located in this Region. The Central Valley Regional Water Board has jurisdiction over the Delta and rivers extending further eastward.

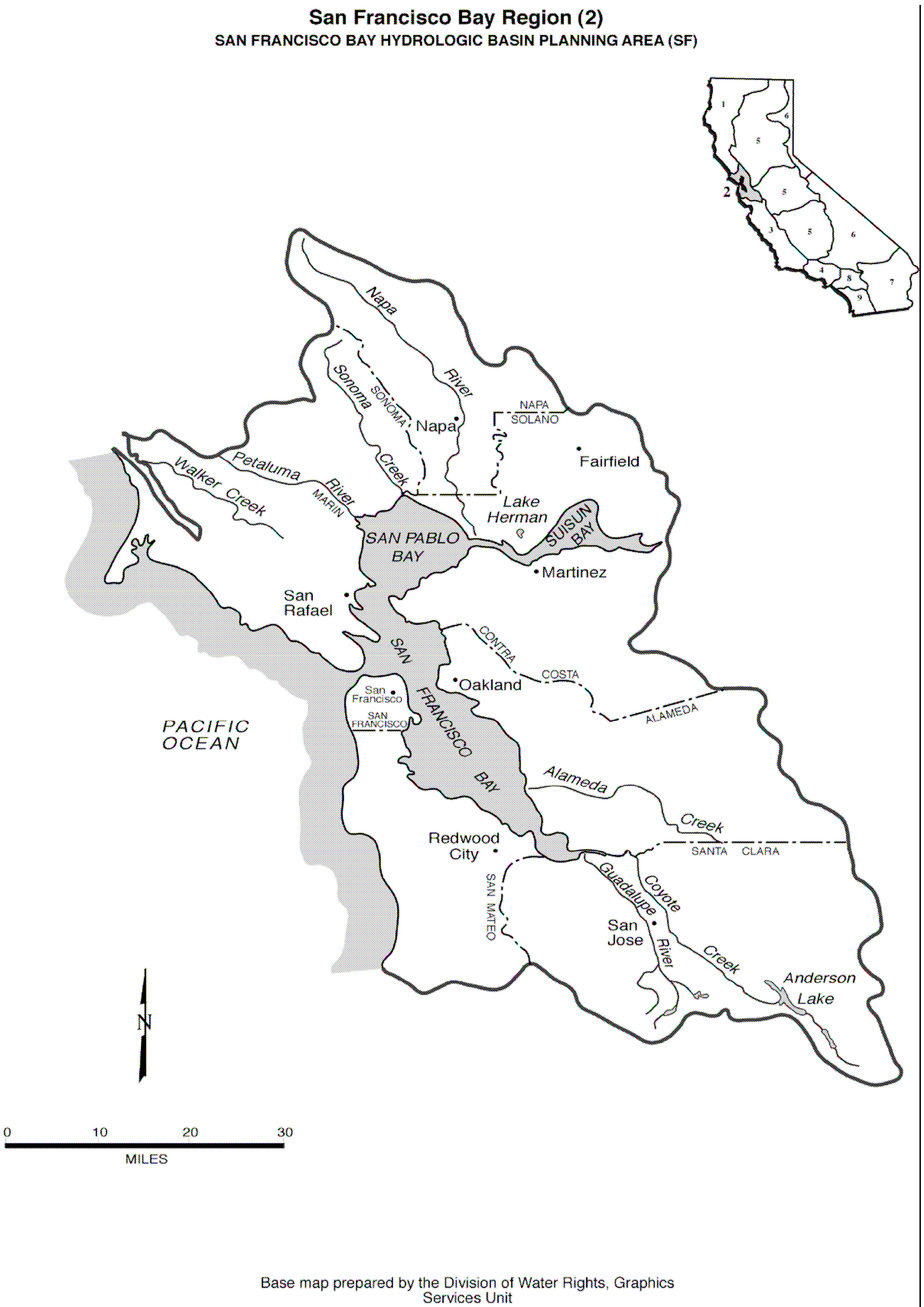


Figure 3.2 San Francisco Bay Region

The San Francisco Estuary is made up of many different types of aquatic habitats that support a great diversity of organisms. Suisun Marsh in Suisun Bay is the largest brackish-water marsh in the United States. San Pablo Bay is a shallow embayment strongly influenced by runoff from the Sacramento and San Joaquin Rivers.
The Central Bay is the portion of the Bay most influenced by oceanic conditions. The South Bay, with less freshwater inflow than the other portions of the Bay, acts more like a tidal lagoon. Together these areas sustain rich communities of aquatic life and serve as important wintering sites for migrating waterfowl and spawning areas for anadromous fish.

Sediment quality-related impairments are summarized in Table 3.1. Tissue listings potentially related to pollutants in sediment are summarized in Table 3.2. Water column listings are presented in Table 3.3.

Table 3.1. Summary of sediment quality related 303(d) listing of bays and estuaries in the San Francisco Region (SWRCB, 2006)

WATER BODY	TYPE[1]	BASIS FOR IMPAIRMENT
Stege Marsh	Estuary	Chlordane, Copper, Dacthal, Dieldrin, Mercury, PCBs[2], Zinc, Sediment Toxicity, Benthic Community Impacts
Islais Creek	Estuary	Chlordane Dieldrin, PAH[3], Sediment Toxicity, Benthic Community Impacts
Mission Creek	Estuary	Chlordane, Dieldrin Lead, Mercury, PAHs[3], PCBs[2], Silver, Zinc, Lead, Mercury, Sediment Toxicity, Benthic Community Impacts
Petaluma River (tidal portion),	Estuary	Nickel
Oakland Inner Harbor (Fruitvale Site)	Bay	Chlordane, PCBs[2], Sediment Toxicity
Oakland Inner Harbor (Pacific Dry-dock Yard)	Bay	Chlordane, Copper, Dieldrin, Lead, Mercury, PCBs[2], Zinc, Sediment Toxicity
Castro Cove, Richmond	Bay	Dieldrin, Mercury, PAHs[3], Selenium
Central Basin, San Francisco Bay	Bay	Dieldrin, Mercury, PAHs[3], Selenium, Sediment Toxicity
San Leandro Bay	Bay	Lead, Mercury, PAHs[3], Chlordane, Dieldrin, Zinc, Sediment Toxicity, Benthic Community Impacts
San Pablo Bay	Bay	

1. Based upon beneficial uses provided in fact sheets (SWRCB, 2006)
2. Polychlorinated biphenyls
3. Polyaromatic hydrocarbons

Table 3.2. 303(d) tissue listings in bays and estuaries of the San Francisco Region (SWRCB, 2006)

WATER BODY	TYPE[1]	BASIS FOR IMPAIRMENT
Carquinez Strait	Bay	Mercury, PCBs[2], Selenium
Central Basin, San Francisco Bay	Bay	Mercury, PCBs[2], Selenium
Oakland Inner Harbor (Fruitvale Site)	Bay	Mercury, PCBs[2], Selenium
Oakland Inner Harbor (Pacific Dry-dock Yard)	Bay	Mercury, PCBs[2], Selenium
Suisun Bay	Estuary	Mercury, PCBs[2], Selenium
Tomales Bay	Bay	Mercury
San Pablo Bay	Bay	Mercury, PCBs[2], Selenium

1. Based upon beneficial uses provided in fact sheets (SWRCB, 2006)
2. Polychlorinated biphenyls
3. Polyaromatic hydrocarbons

Table 3.3. 303(d) Water quality listings in bays and estuaries of the San Francisco Region (SWRCB, 2006)

WATER BODY	TYPE[1]	BASIS FOR IMPAIRMENT
San Francisco Bay, Richardson Bay	Bay	Chlordane, Dieldrin, DDT
San Francisco Bay, San Pablo Bay	Bay	Chlordane, Dieldrin, DDT
San Francisco Bay, Central Basin	Bay	Chlordane, Dieldrin, DDT
San Francisco Bay, Oakland Inner Harbors	Bay	Chlordane, Dieldrin, DDT
San Francisco Bay, San Leandro Bay	Bay	Chlordane, Dieldrin
San Francisco Bay, Lower Basin	Bay	Mercury, Chlordane, Dieldrin, DDT
San Francisco Bay, South Basin	Bay	Mercury, Chlordane, Dieldrin, DDT

1. Based upon beneficial uses provided in fact sheets (SWRCB, 2006)

3.3 CENTRAL COAST REGION

The Central Coast Region comprises all basins (including Carrizo Plain in San Luis Obispo and Kern Counties) draining into the Pacific Ocean from the southern boundary of the Pescadero Creek watershed in San Mateo and Santa Cruz Counties; to the southeastern boundary of the Rincon Creek watershed, located in western Ventura County (Figure 3.3). The Region extends over a 300-mile long by 40-mile wide section of the State's central coast. Its geographic area encompasses all of Santa Cruz, San Benito, Monterey, San Luis Obispo, and Santa Barbara Counties as well as the southern one-third of Santa Clara County, and small portions of San Mateo, Kern, and Ventura Counties. Included in the region are urban areas such as the Monterey Peninsula and the Santa Barbara coastal plain; prime agricultural lands such as the Salinas, Santa Maria, and Lompoc Valleys; National Forest lands; extremely wet areas such as the Santa Cruz Mountains; and arid areas such as the Carrizo Plain. Water bodies in the Central Coast Region are varied. Enclosed bays and harbors in the Region include Morro Bay, Elkhorn Slough, Tembladero Slough, Santa Cruz Harbor, Moss Landing Harbor, San Luis Harbor, and Santa Barbara Harbor. Several small estuaries also characterize the Region, including the Santa Maria River Estuary, San Lorenzo River Estuary, Big Sur River Estuary, and many others. Major rivers, streams, and lakes include San Lorenzo River, Santa Cruz River, San Benito River, Pajaro River, Salinas River, Santa Maria River, Cuyama River, EstrellaRiver and Santa Ynez River, San Antonio Reservoir, Nacimiento Reservoir, Twitchel Reservoir, and Cuchuma Reservoir. The economic and cultural activities in the basin have been primarily agrarian. Livestock grazing persists, but has been combined with hay cultivation in the valleys. Irrigation, with pumped local groundwater, is very significant in intermountain valleys throughout the basin. Mild winters result in long growing seasons and continuous cultivation of many vegetable crops in parts of the basin.

While agriculture and related food processing activities are major industries in the Region, oil production, tourism, and manufacturing contribute heavily to its economy. The northern part of the Region has experienced a significant influx of electronic manufacturing; while offshore oil exploration and production have heavily influenced the southern part. Total population of the Region is estimated at 1.22 million people. Water quality problems frequently encountered in the Central Coastal Region include excessive salinity or hardness of local groundwaters. An increase in nitrate concentrations is a growing problem in a number of areas, in both groundwater and surface water. Surface waters suffer from bacterial contamination, nutrient enrichment, and siltation in a number of watersheds. Pesticides are a concern in agricultural areas and associated downstream water bodies. ~~A Summary of s~~ Sediment quality-related impairments and water column listings associated with toxic pollutants are summarized in Tables 3.4 and 3.5 respectively.

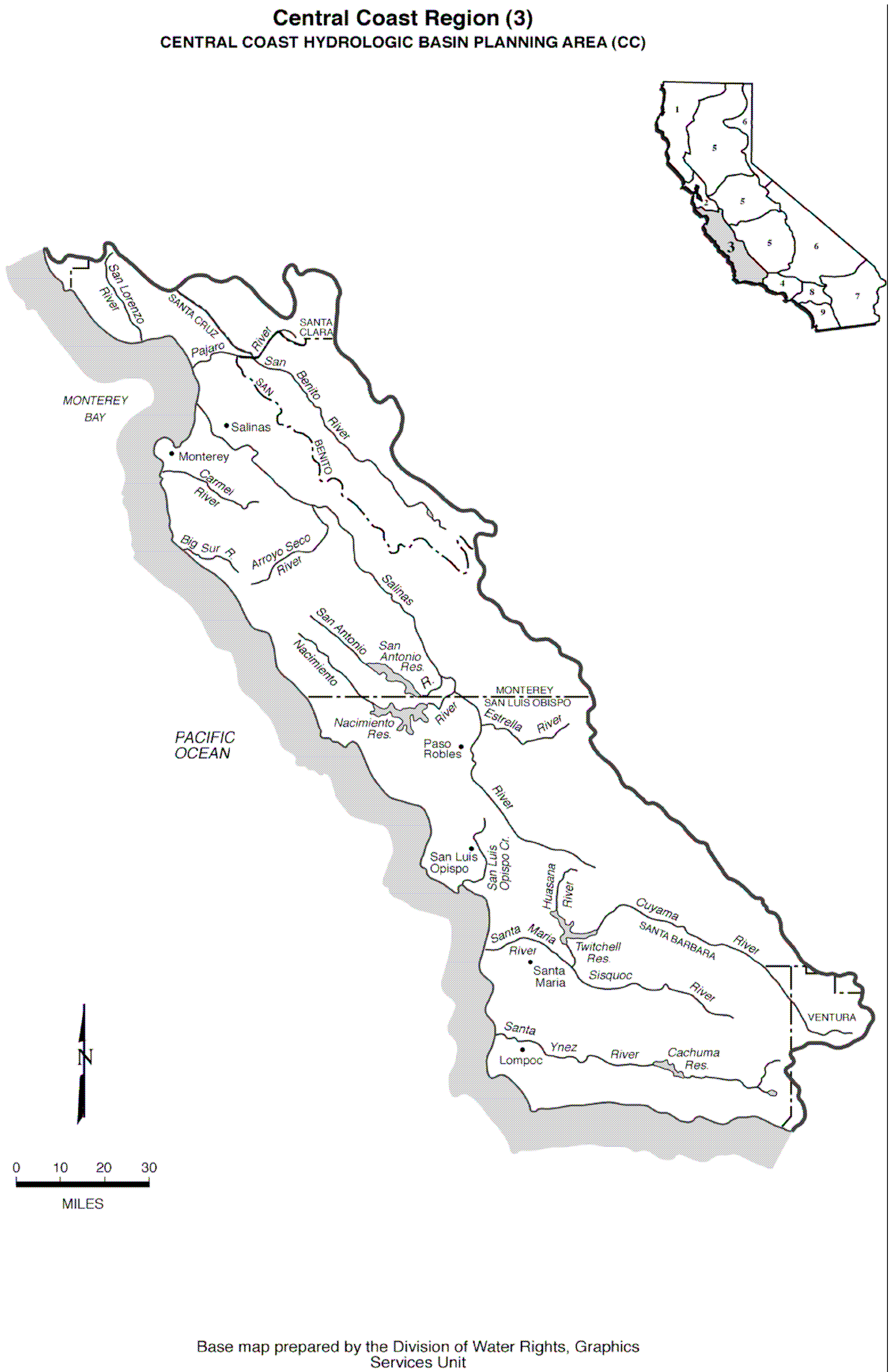


Figure 3.3 Central Coast Region

Table 3.4 303(d) listings related to sediment quality in bays and estuaries of the Central Coast Region (SWRCB, 2006).

WATER BODY	TYPE[1]	BASIS FOR IMPAIRMENT
Carpenteria Marsh (El Estero Marsh)	Estuary	Priority Organics
Elkhorn Slough	Estuary	Pesticides
Monterey Harbor	Bay	Metals, Toxicity
Moss Landing Harbor	Bay	Pesticides
Moro Cojo Slough	Estuary	Pesticides
Old Salinas River Estuary	Estuary	Pesticides
Salinas River Lagoon (North	Bay	Pesticides

1. Based upon beneficial uses provided in fact sheets (SWRCB, 2006)
2. Polychlorinated biphenyls
3. Polyaromatic hydrocarbons

Table 3.5 303(d) listings related to water quality in bays and estuaries of the Central Coast Region (SWRCB, 2006).

Water Body	TYPE[1]	BASIS FOR IMPAIRMENT
Monterey Harbor	Bay	Metals, Toxicity
Moss Landing Harbor	Bay	Pesticides

1. Based upon beneficial uses provided in fact sheets (SWRCB, 2006)

3.4 LOS ANGELES REGION

The Los Angeles Region comprises all basins draining into the Pacific Ocean between the southeastern boundary of the watershed of Rincon Creek, located in western Ventura County, and a line which coincides with the southeastern boundary of Los Angeles County, from the Pacific Ocean to San Antonio Peak, and follows the divide, between the San Gabriel River and Lytle Creek drainages to the divide between Sheep Creek and San Gabriel River drainages (Figure 3.4).

The Region encompasses all coastal drainages flowing into the Pacific Ocean between Rincon Point (on the coast of western Ventura County) and the eastern Los Angeles County line, as well as the drainages of five coastal islands (Anacapa, San Nicolas, Santa Barbara, Santa Catalina and San Clemente). In addition, the Region includes all coastal waters within three miles of the continental and island coastlines.

Two large deepwater harbors (Los Angeles and Long Beach Harbors) and one smaller deepwater harbor (Port Hueneme) are contained in the Region. There are small craft marinas within the harbors, as well as tank farms, naval facilities, fish processing plants, boatyards, and container terminals.

Several small-craft marinas also exist along the coast (Marina del Rey, King Harbor, Ventura Harbor); these contain boatyards, other small businesses and dense residential development.

Several large, primarily concrete-lined rivers (Los Angeles River, San Gabriel River) lead to unlined tidal prisms, which are influenced by marine waters. Salinity may be greatly reduced following rains since these rivers drain large urban areas composed of mostly impermeable surfaces. Some of these tidal prisms receive a considerable amount of freshwater throughout the year from publicly owned treatment works discharging tertiary-treated effluent. Lagoons are located at the mouths of other rivers draining relatively undeveloped areas (Mugu Lagoon, Malibu Lagoon, Ventura River Estuary, and Santa Clara River Estuary). There are also a few isolated coastal brackish water bodies receiving runoff from agricultural or residential areas.

Santa Monica Bay, which includes the Palos Verdes Shelf, dominates a large portion of the open coastal water bodies in the Region. The Region's coastal water bodies also include the areas along the shoreline of Ventura County and the waters surrounding the five offshore islands in the region.

Sediment quality, tissue and water quality listings for toxic pollutants are summarized in Tables 3.6, 3.7 and 3.8 respectively.

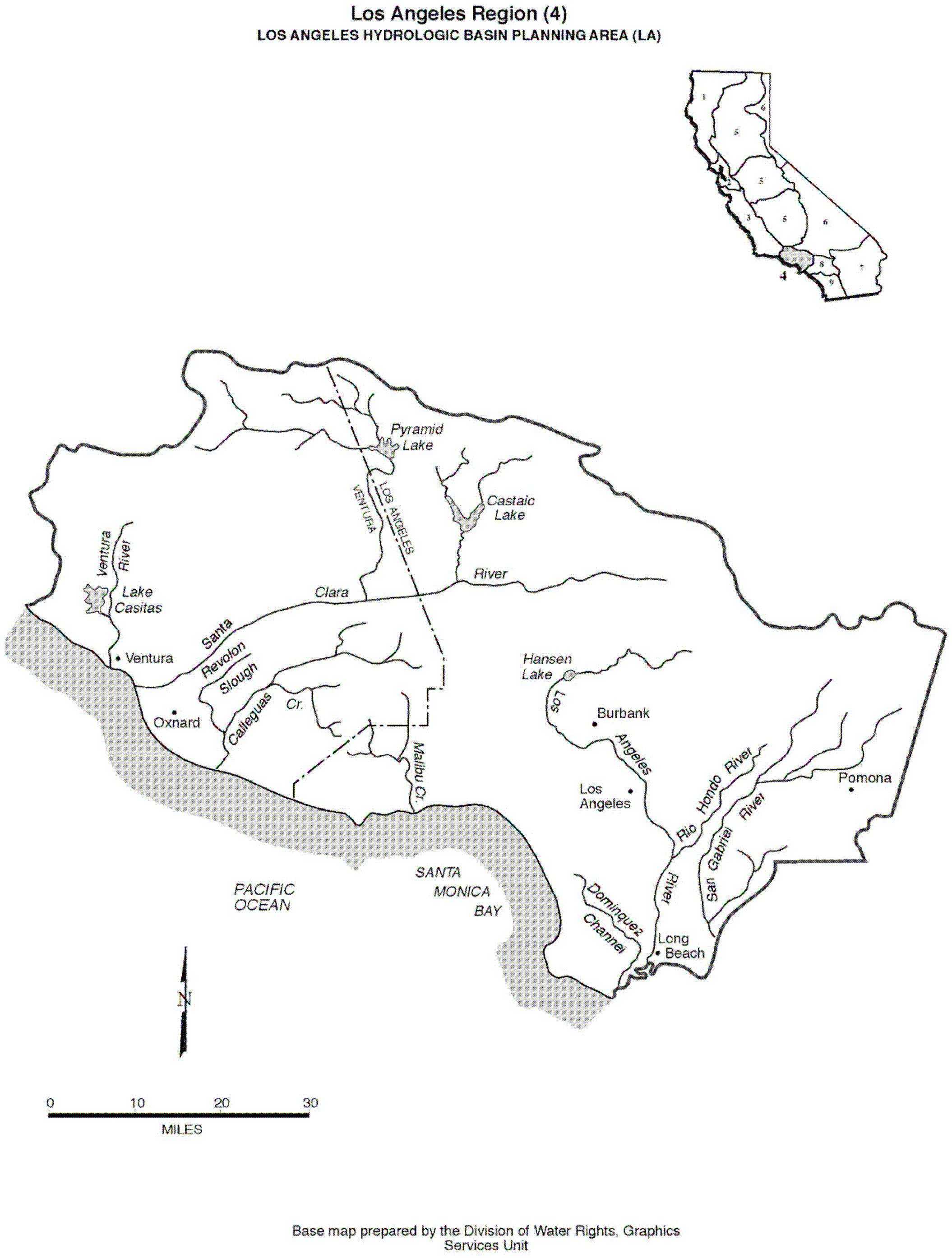


Figure 3.4 Los Angeles Region

Table 3.6. Summary of sediment quality related 303(d) listing of bays and estuaries in the Los Angeles Region (SWRCB, 2006)

WATER BODY	TYPE[1]	BASIS FOR IMPAIRMENT
Ballona Creek Estuary	Estuary	Chlordane, DDT, Lead, PCBs[2], PAHs[3], Zinc, Sediment Toxicity, Benthic Community Impacts
Calleguas Creek Reach 1 (Mugu Lagoon)	Estuary	DDT, Sediment Toxicity
Channel Islands Harbor	Bay	Lead, Zinc
Dominguez Channel	Estuary	DDT, Zinc, Sediment Toxicity, Benthic Community Impacts
Los Angeles Harbor - Fish Harbor	Bay	Benzo[a]anthracene Dibenz[a,h]anthracene, Chlordane, Chrysene (C1-C4) Copper, Lead, Mercury, Phenanthrene, Pyrene, Zinc, Sediment toxicity
Los Angeles River Estuary (Queensway Bay)	Estuary	Chlordane, DDT, Lead, PCBs[2], Sediment Toxicity
Los Angeles Harbor - Inner Cabrillo Beach	Bay	Copper
Los Angeles Harbor - Consolidated Slip	Bay	Cadmium, Chlordane, Chromium, Copper, DDT, Lead, Mercury, PCBs[2], Zinc, Sediment Toxicity Benthic Community Impacts
Los Angeles/Long Beach Inner Harbor	Bay	Benthic Community Impacts, Sediment Toxicity
Los Cerritos Channel	Estuary	Chlordane
Malibu Lagoon	Estuary	Benthic Community Impacts
Marina del Rey Harbor - Back Basins	Bay	Chlordane, Copper, DDT, Lead, PCBs[2], Zinc, Sediment Toxicity
McGrath Lake	Estuary	Dieldrin, PCBs, Sediment Toxicity
San Pedro Bay Near/Off Shore Zones	Bay	Chlordane, Copper, Chromium, DDT, PAHs[3], Zinc, Benthic Community Impacts, Sediment Toxicity

1. Based upon beneficial uses provided in fact sheets (SWRCB, 2006)
2. Polychlorinated biphenyls
3. Polyaromatic hydrocarbons

Table 3.7. Summary of 303(d) tissue listings in bays and estuaries of the Los Angeles Region included (SWRCB, 2006)

Water Body	TYPE[1]	BASIS FOR IMPAIRMENT
Ballona Creek Estuary	Estuary	Chlordane, PCBs
Dominguez Channel	Estuary	Chlordane, DDT, Dieldrin, Lead
Los Angeles Harbor - Fish Harbor	Bay	DDT, PCBs
Los Angeles River Estuary (Queensway Bay)	Estuary	DDT, PCBs
Los Angeles Harbor - Consolidated Slip	Bay	Dieldrin
Los Angeles/Long Beach Inner Harbor	Bay	Chlordane, DDT, PCBs
Los Angeles/Long Beach Outer Harbor (inside breakwater)	Bay	Chlordane, DDT

1. Based upon beneficial uses provided in fact sheets (SWRCB, 2006)
2. Polychlorinated biphenyls
3. Polyaromatic hydrocarbons

Table 3.8. Summary of 303(d) water quality listings in bays and estuaries of the Los Angeles Region included (SWRCB, 2006)

Water Body	TYPE[1]	BASIS FOR IMPAIRMENT
Calleguas Creek Reach 1 (Mugu Lagoon)	Estuary	Copper, Mercury, Nickel
Dominguez Channel	Estuary	PAHs
Los Angeles Harbor - Fish Harbor	Bay	PAHs, DDT, PCBs[2], Copper, Lead, Mercury, Zinc
Los Angeles Harbor - Consolidated Slip	Bay	Chlordane, DDT, PCBs[2], Toxaphene
Los Angeles/Long Beach Inner Harbor	Bay	DDT, PCBs[2]
Los Angeles Harbor - Inner Cabrillo Beach Area	Bay	Copper, DDT, PCBs[2]
Los Angeles/Long Beach Outer Harbor (inside breakwater)	Bay	DDT, PCBs[2]
Marina del Rey Harbor - Back Basins	Bay	Chlordane, DDT, Dieldrin, PCBs[2]
San Pedro Bay Near/Off Shore Zones	Bay	Chlordane, PCBs[2]

Santa Clara River Estuary	Estuary	Aldrin, Dieldrin, Chlordane, Endrin, Heptachlor, Heptachlor Epoxide, Hexachlorocyclohexane (including Lindane), Endosulfan, and Toxaphene

1. Based upon beneficial uses provided in fact sheets (SWRCB, 2006)
2. Polychlorinated biphenyls

3.5 CENTRAL VALLEY REGION

The Central Valley Region includes approximately 40 percent of the land in California stretching from the Oregon border to the Kern County/ Los Angeles county line. The Region is divided into three basins. For planning purposes, the Sacramento River Basin and the San Joaquin River basin are covered under one Basin Plan and the Tulare Lake Basin is covered under a separate distinct one (Figures 3.5, 3.6 and 3.7).

The Sacramento River Basin covers 27,210 square miles and includes the entire area drained by the Sacramento River. The principal streams are the Sacramento River and its larger tributaries: the Pitt, Feather, Yuba, Bear, and American Rivers to the East; and Cottonwood, Stony, Cache, and Putah Creek to the west. Major reservoirs and lakes include Shasta, Oroville, Folsom, Clear Lake, and Lake Berryessa.

The San Joaquin River Basin covers 15,880 square miles and includes the entire area drained by the San Joaquin River. Principal streams in the basin are the San Joaquin River and its larger tributaries: the Consumnes, Mokelumne, Calaveras, Stanislaus, Tuolumne, Merced, Chowchilla, and Fresno Rivers. Major reservoirs and lakes include Pardee, New Hogan, Millerton, McClure, Don Pedro, and New Melones.

The Tulare Lake Basin covers approximately 16,406 square miles and comprises the drainage area of the San Joaquin Valley south of the San Joaquin River ~~(Figure 7)~~. The planning boundary between the San Joaquin River Basin and the Tulare Lake Basin is defined by the northern boundary of Little Pinoche Creek basin eastward along the channel of the San Joaquin River to Millerton Lake in the Sierra Nevada foothills, and then along the southern boundary of the San Joaquin River drainage basin. Main rivers within the basin include the King, Kaweah, Tule, and Kern Rivers, which drains the west face of the Sierra Nevada Mountains. Imported surface water supplies enter the basin through the San Luis Drain- California Aqueduct System, Friant- Kern Channel and the Delta Mendota Canal.

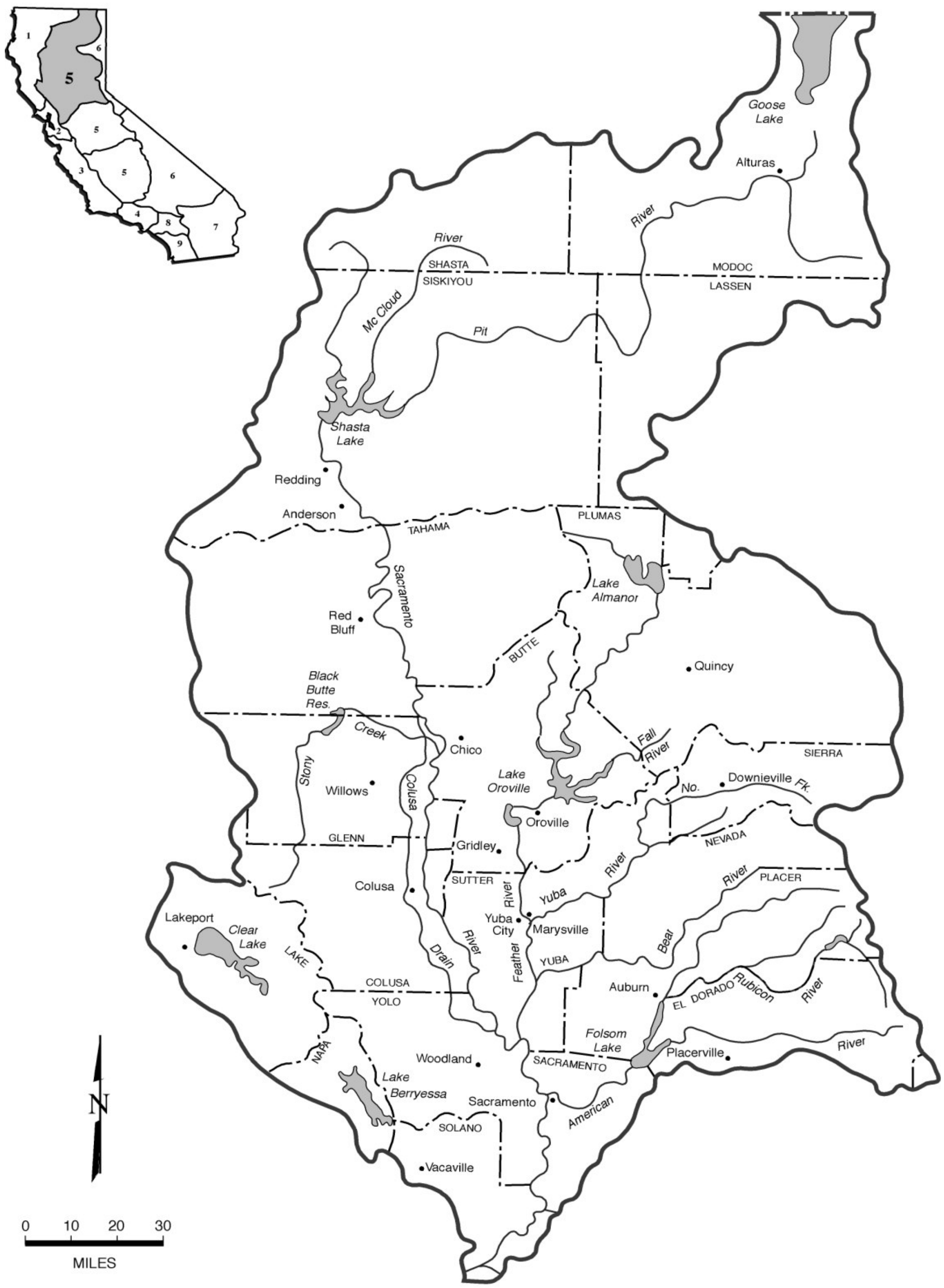
The two northern most basins are bound by the crests of the Sierra Nevada on the east and the Coast Range and Klamath Mountains on the west. They extend about 400 miles from the California-Oregon border southward to the headwaters of the San Joaquin River. These two river basins cover about one fourth of the total area of the State and over 30 percent of the State's irrigable land. The Sacramento and San Joaquin Rivers furnish roughly 50 percent of the State's water supply. Surface water from the two drainage basins meet and form the Delta, which ultimately drains into the San Francisco Bay. The Delta is a maze of river channels and diked islands covering roughly 1,150 square miles, including 78 square miles of water area. Two major water projects located in the South Delta, the Federal Central Valley Project and the State Water Project, deliver water from the Delta to Southern California, the San Joaquin

Valley, Tulare Lake Basin, the San Francisco Bay Area, as well as within the Delta boundaries. The legal boundary of the Delta is described in Water Code section 12220.

Tissue and water quality listings for toxic pollutants are summarized in Tables 3.9 and 3.10. The major pollutants affecting estuarine waters in the Central Valley include nutrients, metals, pathogens, and pesticides among others (SWRCB, 2003a).

Central Valley Region (5)

SACRAMENTO HYDROLOGIC BASIN PLANNING AREA (SB)

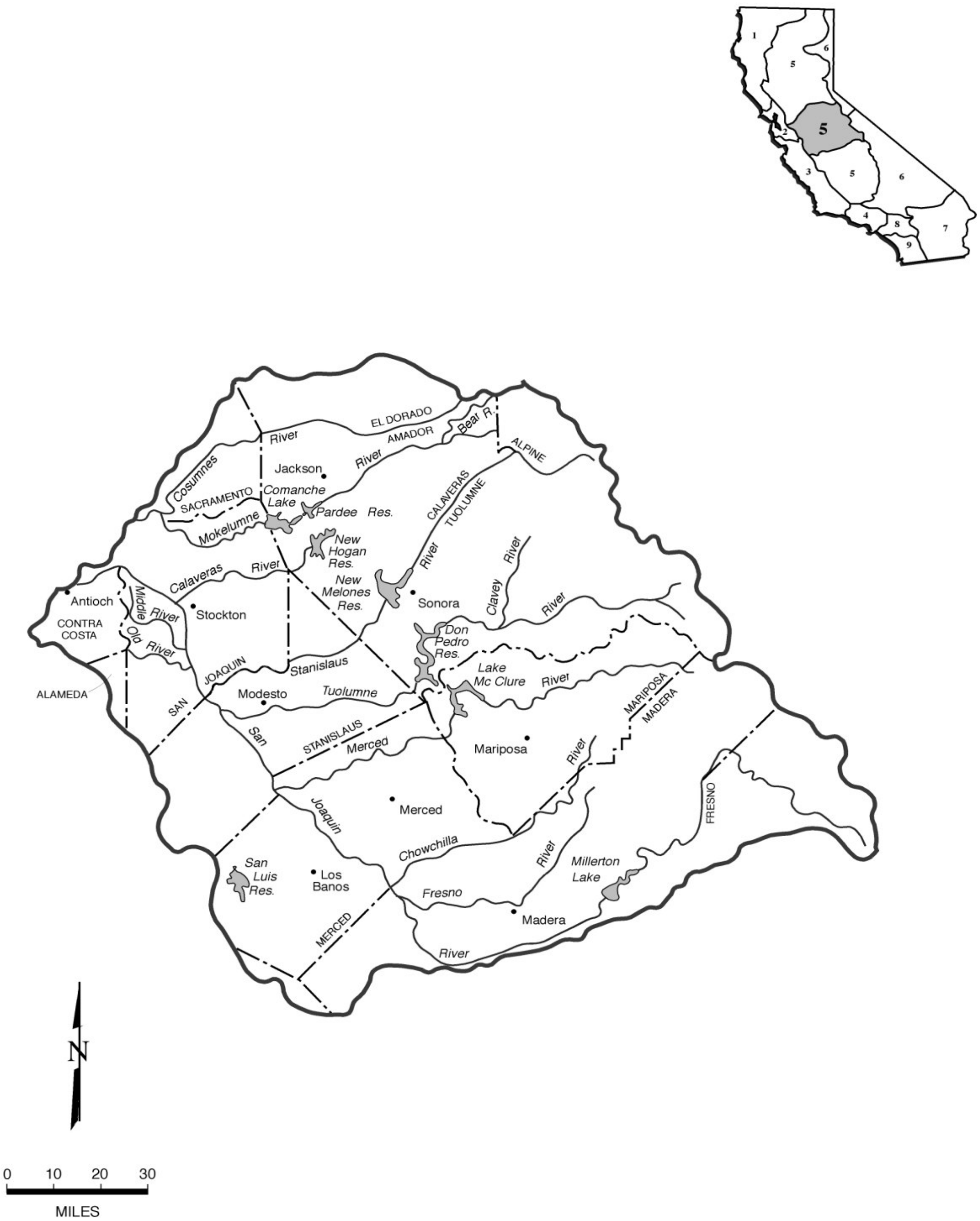


Base map prepared by the Division of Water Rights, Graphics Services Unit

Figure 3.5 Central Valley Region Sacramento Hydrologic Basin

Central Valley Region (5)

SAN JOAQUIN HYDROLOGIC BASIN PLANNING AREA (SJ)



Base map prepared by the Division of Water Rights, Graphics Services Unit

Figure 3.6 Central Valley Region San Joaquin Hydrologic Basin

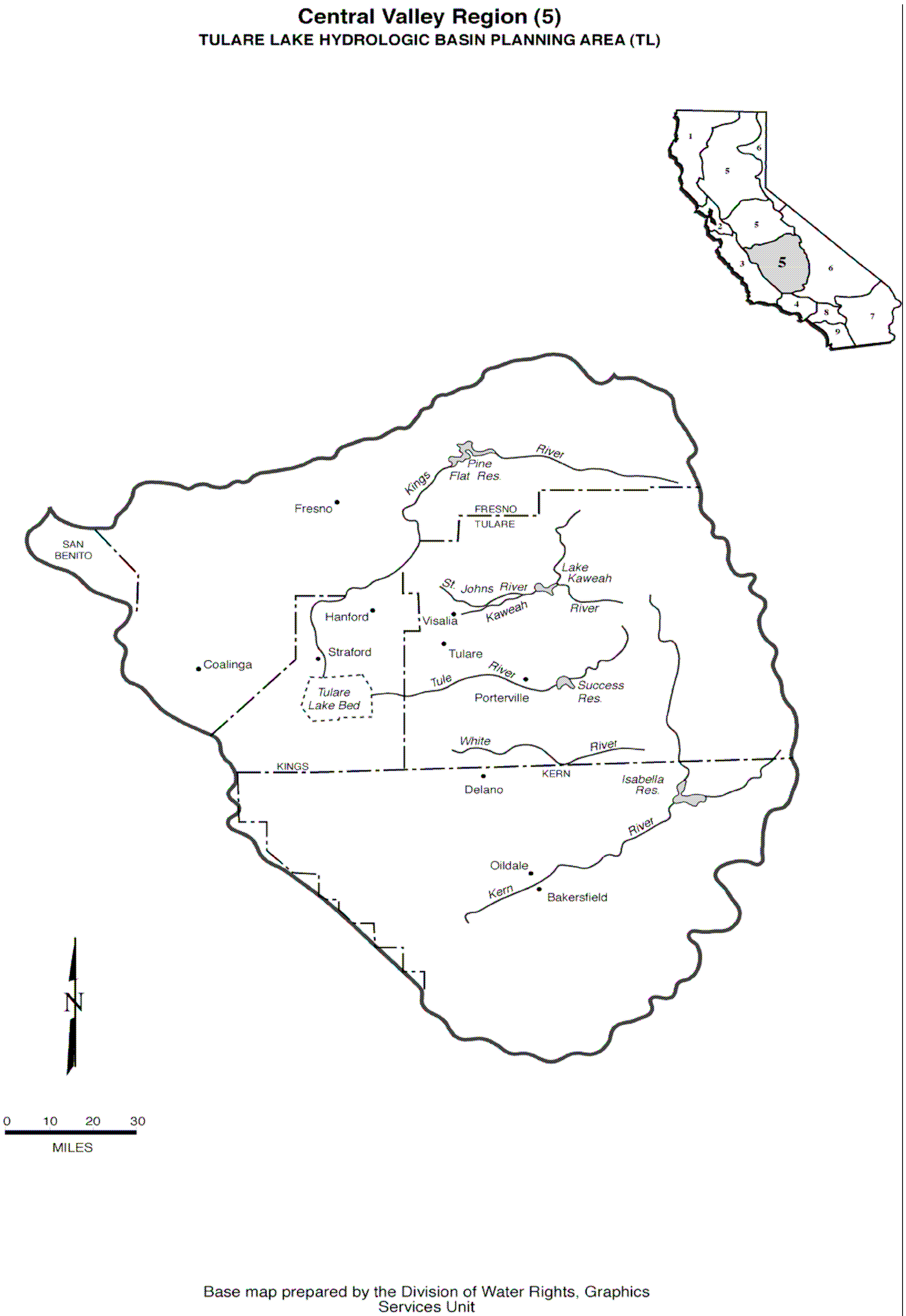


Figure 3.7 Central Valley Region Tulare lake Hydrologic Basin

Table 3.9. Summary of 303(d) tissue listings in estuaries of the Central Valley Region (SWRCB, 2006)

WATER BODY	TYPE[1]	BASIS FOR IMPAIRMENT
Delta Waterways Northern Portion	Estuary	DDT, PCBs[2], Mercury
Delta Waterways Southern Portion	Estuary	DDT, Mercury
Delta Waterways Central Portion	Estuary	DDT, PCBs[2], Mercury
Delta Waterways Eastern Portion	Estuary	DDT, Mercury
Delta Waterways Western Portion	Estuary	DDT, Mercury
Delta Waterways Stockton Ship Channel	Estuary	DDT, Dioxins, Mercury, PCBs[2]

1. Based upon beneficial uses provided in fact sheets (SWRCB, 2006)
2. Polychlorinated biphenyls
3. Polyaromatic hydrocarbons

Table 3.10. Summary of 303(d) water quality listings in estuaries of the Central Valley Region (SWRCB, 2006)

WATER BODY	TYPE[1]	BASIS FOR IMPAIRMENT
Delta Waterways Northern Portion	Estuary	Chlorpyrifos, DDT, Diazinon, Mercury, Aldrin, Dieldrin, Chlordane, Endrin, Heptachlor, Heptachlor Epoxide, Hexachlorocyclohexane (including Lindane), Endosulfan, and Toxaphene
Delta Waterways Southern Portion	Estuary	Chlorpyrifos, DDT, Diazinon, Mercury, Aldrin, Dieldrin, Chlordane, Endrin, Heptachlor, Heptachlor Epoxide, Hexachlorocyclohexane (including Lindane), Endosulfan, and Toxaphene
Delta Waterways Central Portion	Estuary	Chlorpyrifos, DDT, Diazinon, Mercury, Aldrin, Dieldrin, Chlordane, Endrin, Heptachlor, Heptachlor Epoxide, Hexachlorocyclohexane (including Lindane), Endosulfan, and Toxaphene
Delta Waterways Eastern Portion	Estuary	Chlorpyrifos, DDT, Diazinon, Mercury, Aldrin, Dieldrin, Chlordane, Endrin, Heptachlor, Heptachlor Epoxide, Hexachlorocyclohexane (including Lindane), Endosulfan, and Toxaphene
Delta Waterways Western Portion	Estuary	Chlorpyrifos, DDT, Diazinon, Mercury, Aldrin, Dieldrin, Chlordane, Endrin, Heptachlor, Heptachlor Epoxide, Hexachlorocyclohexane (including Lindane), Endosulfan, and Toxaphene
Delta Waterways Stockton Ship Channel	Estuary	Chlorpyrifos, DDT, Diazinon, Mercury, Aldrin, Dieldrin, Chlordane, Endrin, Heptachlor, Heptachlor Epoxide, Hexachlorocyclohexane (including Lindane), Endosulfan, and Toxaphene

1. Based upon beneficial uses provided in fact sheets (SWRCB, 2006)

There are also a number of sediment quality-related 303(d) listings for waters upstream of affected bays and estuaries (see SWRCB, 2006). Impaired sediments can be carried downstream and settle into bays and estuaries, contributing to existing impairments or causing new impairments.

3.6 SANTA ANA REGION

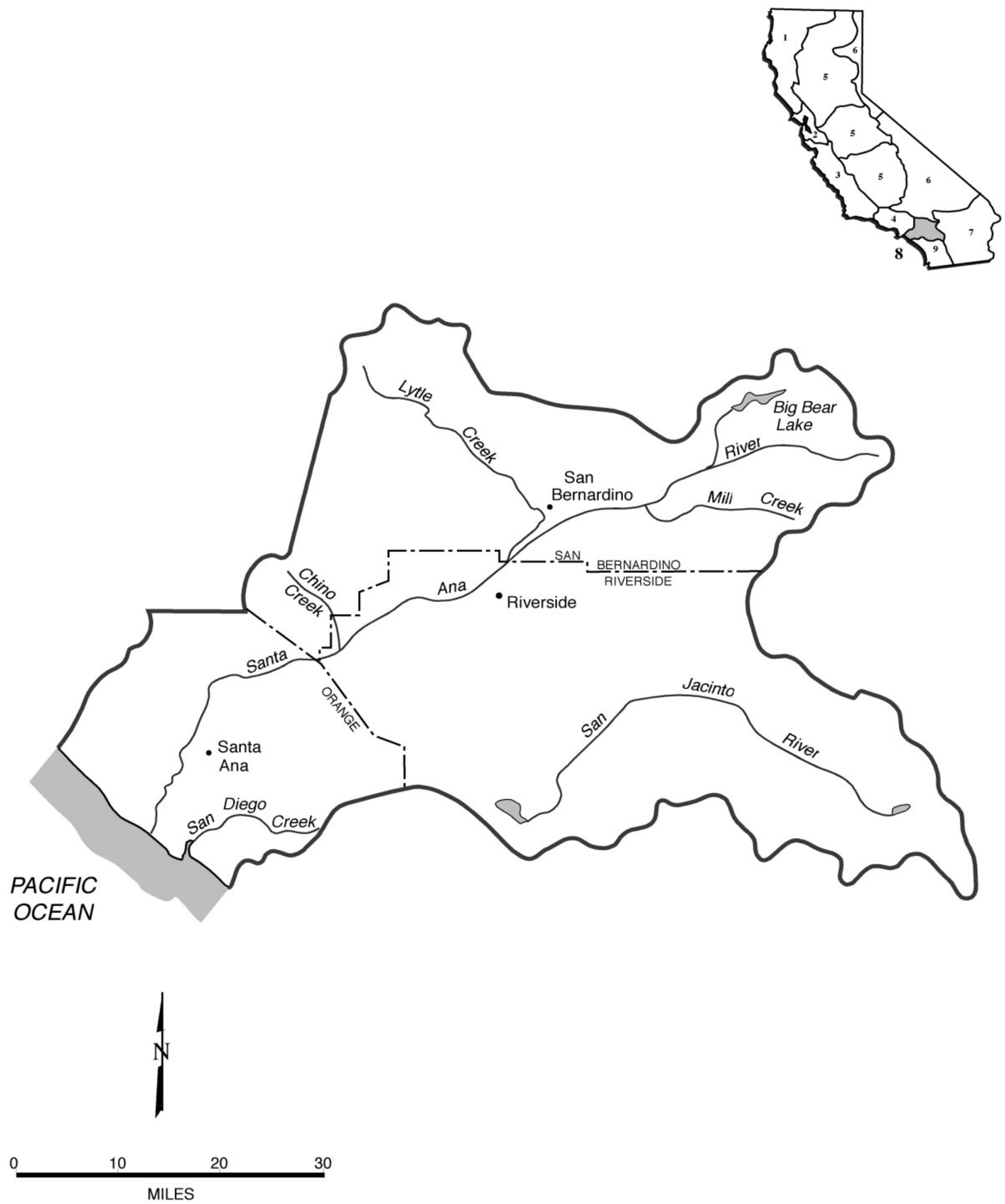
The Santa Ana Region comprises all basins draining into the Pacific Ocean between the southern boundary of the Los Angeles Region and the drainage divide between Muddy and Moro Canyons, from the ocean to the summit of San Joaquin Hills; along the divide between lands draining into Newport Bay and Laguna Canyon to Niguel Road; along Niguel Road and Los Aliso Avenue to the divide between Newport Bay and Aliso Creek drainages; and along the divide and the southeastern boundary of the Santa Ana River drainage to the divide between Baldwin Lake and Mojave Desert drainages; to the divide between the Pacific Ocean and Mojave Desert drainages (Figure 3.8). The Santa Ana Region is the smallest of the nine regions in the state (2,800 square miles) and is located in southern California, roughly between Los Angeles and San Diego.

Although small geographically, the region's four-plus million residents (1993 estimate) make it one of the most densely populated regions. The climate of the Santa Ana Region is classified as Mediterranean: generally dry in the summer with mild, wet winters. The average annual rainfall in the region is about fifteen inches, most of it occurring between November and March.

The enclosed bays in the Region include Newport Bay, Bolsa Bay (including Bolsa Chica Marsh), and Anaheim Bay. Principal Rivers include Santa Ana, San Jacinto and San Diego. Lakes and reservoirs include Big Bear, Hemet, Mathews, Canyon Lake, Lake Elsinore, Santiago Reservoir, and Perris Reservoir.

The section 2002 303(d) list for the Santa Ana Region included nine water bodies affecting an estimated 7,886 acres (bays, estuaries, lakes, and wetlands) and 24 water bodies affecting 191 miles of rivers and shoreline. The major pollutants affecting these water bodies included nutrients, metals, pathogens, pesticides, and sediments among others (SWRCB 2003a). Sediment quality-related impairments are summarized in Table 3.11. Tissue listings potentially related to pollutants in sediment are summarized in Table 3.12.

Santa Ana Region (8)
SANTA ANA HYDROLOGIC BASIN PLANNING AREA (SA)



Base map prepared by the Division of Water Rights, Graphics Services Unit

Figure 3.8 Santa Ana Region

Table 3.11. Summary of sediment quality related 303(d) listing of bays and estuaries in the Santa Ana Region (SWRCB, 2006)

WATER BODY	TYPE[1]	BASIS FOR IMPAIRMENT
Anaheim Bay	Bay	Sediment Toxicity
Huntington Harbour	Bay	Chlordane, Lead, Sediment Toxicity
Newport Bay – Lower	Bay	Chlordane, Copper, DDT, PCBs, Sediment Toxicity
Newport Bay – Upper (Ecological Reserve)	Bay	Chlordane, DDT, PCBs, Metals, Benthic Community Degradation, Sediment Toxicity
Rhine Channel	Bay	Sediment Toxicity

1. Based upon beneficial uses provided in fact sheets (SWRCB, 2006)
2. Polychlorinated biphenyls
3. Polyaromatic hydrocarbons

Table 3.12. Summary of 303(d) tissue listing of bays and estuaries in the Santa Ana Region (SWRCB, 2006)

WATER BODY	TYPE[1]	BASIS FOR IMPAIRMENT
Anaheim Bay	Bay	Chlordane, Dieldrin, PCBs[2]
Huntington Harbour	Bay	PCBs[2]

1. Based upon beneficial uses provided in fact sheets (SWRCB, 2006)
2. Polychlorinated biphenyls
3. Polyaromatic hydrocarbons

Table 3.13. Summary of 303(d) water quality listings for toxic pollutants in bays and estuaries of the Santa Ana Region (SWRCB, 2006)

WATER BODY	TYPE[1]	BASIS FOR IMPAIRMENT
Huntington Harbour	Bay	Copper
Bolsa Bay	Bay	Copper
Upper Newport Bay	Bay	Copper, PCBs[2], Chlordane, DDT, Metals
Lower Newport Bay	Bay	Copper, PCBs[2], Chlordane, DDT
Rhine Channel	Bay	Copper, Lead, Mercury, Zinc, PCB[2]

1. Based upon beneficial uses provided in fact sheets (SWRCB, 2006)
2. Polychlorinated biphenyls
3. Polyaromatic hydrocarbons

3.7 SAN DIEGO REGION

The San Diego Region comprises all basins draining into the Pacific Ocean between the southern boundary of the Santa Ana Region and the California-Mexico boundary (Figure 3.9). The San Diego Region is located along the coast of the Pacific Ocean from the Mexican border to north of Laguna Beach. The Region is rectangular in shape and extends approximately 80 miles along the coastline and 40 miles east to the crest of the mountains. The Region includes portions of San Diego, Orange, and Riverside Counties.

The population of the Region is heavily concentrated along the coastal strip. Six deepwater sewage outfalls and one across the beach discharge from the new border plant at the Tijuana River empty into the ocean. Two harbors, Mission Bay and San Diego Bay, support major recreational and commercial boat traffic. Coastal lagoons are found along the San Diego County coast at the mouths of creeks and rivers.

The 2002 section 303(d) list for the San Diego Region included 26 water bodies affecting an estimated 6,907 acres (bays, estuaries, lakes, and wetlands) and 40 water bodies affecting 148 miles of rivers and shoreline. The major pollutants affecting these water bodies included nutrients, metals, pathogens, pesticides, and sediments among others (SWRCB, 2003a).

Weather patterns are Mediterranean in nature with an average rainfall of approximately ten inches per year occurring along the coast. Almost all the rainfall occurs during wet cool winters. The Pacific Ocean generally has cool water temperatures due to upwelling. This nutrient-rich water supports coastal beds of giant kelp. The cities of San Diego, National City, Chula Vista, Coronado, and Imperial Beach surround San Diego Bay in the southern portion of the Region.

San Diego Bay is long and narrow, 15 miles in length and approximately one mile across. A deep-water harbor, San Diego Bay has experienced waste discharge from former sewage outfalls, industries, and urban runoff. Up to 9,000 vessels may be moored there. San Diego Bay also hosts four major U.S. Navy bases with approximately 80 surface ships and submarines. Coastal waters include bays, harbors, estuaries, beaches, and open ocean. Sediment quality-related impairments are summarized in Table 3.14. Tissue listings potentially related to pollutants in sediment are summarized in Table 3.15.

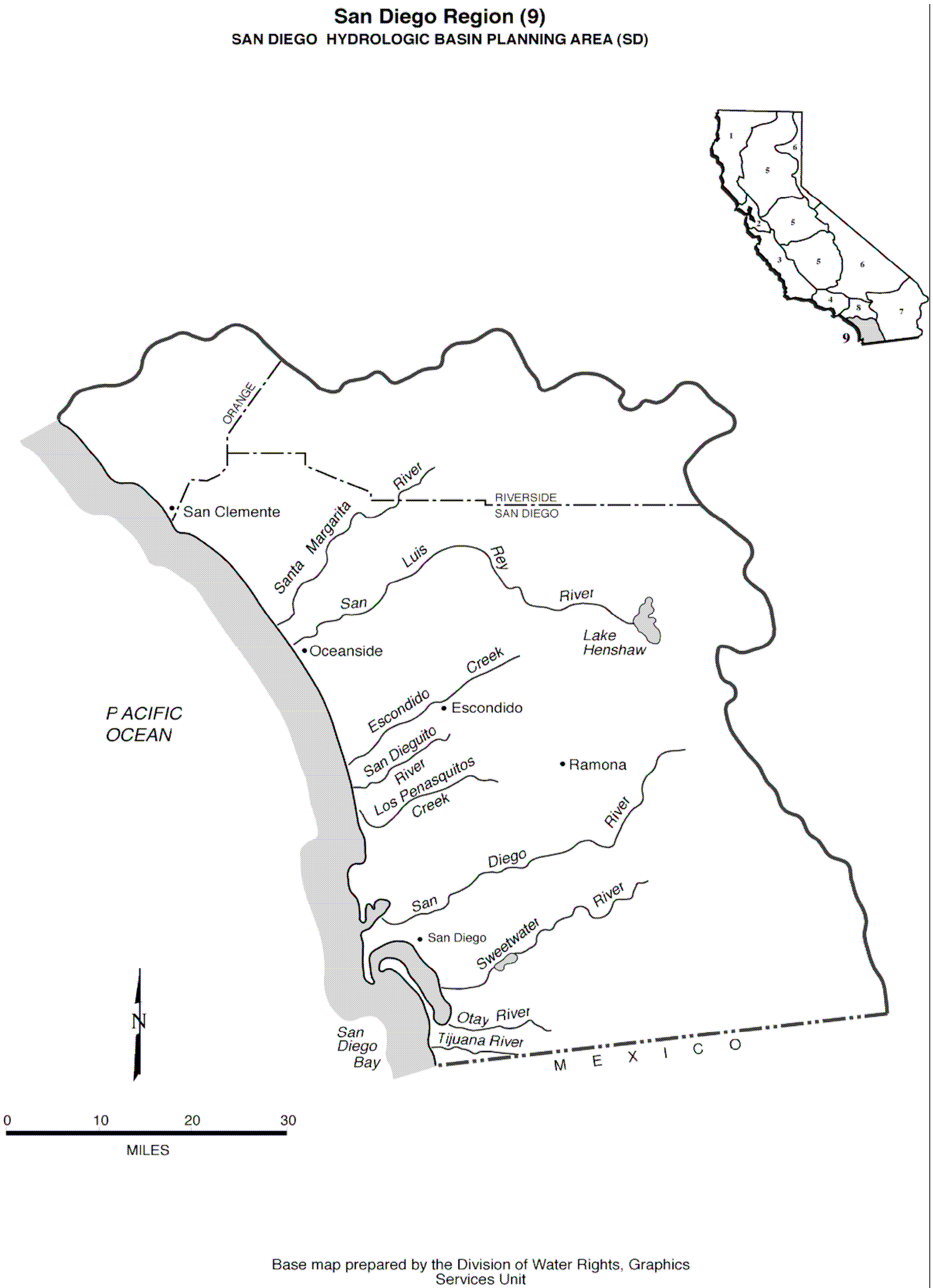


Figure 3.9 San Diego Region

Table 3.14. Summary of sediment quality related 303(d) listing of bays and estuaries in the San Diego Region (SWRCB, 2006)

WATER BODY	TYPE[1]	BASIS FOR IMPAIRMENT
San Diego Bay Shoreline, 32nd St San Diego Naval Station	Bay	Benthic Community Effects, Sediment Toxicity
San Diego Bay Shoreline, Downtown Anchorage	Bay	Benthic Community Effects, Sediment Toxicity
San Diego Bay Shoreline, near Chollas Creek	Bay	Benthic Community Effects, Sediment Toxicity
San Diego Bay Shoreline, near Coronado Bridge	Bay	Benthic Community Effects, Sediment Toxicity
San Diego Bay Shoreline, 9 B near sub base	Bay	Benthic Community Effects, Sediment Toxicity
San Diego Bay Shoreline, near Switzer Creek	Bay	Chlordane, Lindane/Hexachlorocyclohexane (HCH), PAHs
San Diego Bay Shoreline, North of 24th Street Marine Terminal	Bay	Benthic Community Effects, Sediment Toxicity
San Diego Bay Shoreline, Seventh Street Channel	Bay	Benthic Community Effects, Sediment Toxicity
San Diego Bay Shoreline, Vicinity of B St and Broadway Piers	Bay	Benthic Community Effects, Sediment Toxicity

1. Based upon beneficial uses provided in fact sheets (SWRCB, 2006)
2. Polychlorinated biphenyls
3. Polyaromatic hydrocarbons

Table 3.15. Summary of sediment quality related 303(d) tissue listing of bays and estuaries in the San Diego Region (SWRCB, 2006)

WATER BODY	TYPE[1]	BASIS FOR IMPAIRMENT
San Diego Bay	Bay	PCBs

1. Based upon beneficial uses provided in fact sheets (SWRCB, 2006)
2. Polychlorinated biphenyls
3. Polyaromatic hydrocarbons

Table 3.16. Summary of water column related 303(d) listing for toxic pollutants in bays and estuaries of the San Diego Region (SWRCB, 2006)

WATER BODY	TYPE[1]	BASIS FOR IMPAIRMENT
Mission Bay	Bay	Lead
San Diego Bay Shoreline, near Switzer Creek	Bay	Chlordane, PAHs
San Diego Bay Shoreline at Coronado Cays	Bay	Copper
San Diego Bay, Shoreline at Glorietta Bay	Bay	Copper
San Diego Bay, Shoreline at Harbor Island (East Basin)	Bay	Copper
San Diego Bay, Shoreline at Harbor Island (West Basin)	Bay	Copper
San Diego Bay, Shoreline at Marriott Marina	Bay	Copper
San Diego Bay, Shoreline between Sampson and 28th St.	Bay	Copper
San Diego Bay, Shoreline Chula Vista Marina	Bay	Copper

1. Based upon beneficial uses provided in fact sheets (SWRCB, 2006)
2. Polychlorinated biphenyls
3. Polyaromatic hydrocarbons

4. REGULATORY BASELINE

This section describes current state and federal laws, programs, and practices that govern sediment quality in bays and estuaries. These laws, programs and practices represent the regulatory baseline for measuring incremental impacts of the draft Part 1. As explained in greater detail in the following discussion, the basin plans for the coastal Regional Water Boards all contain narrative water quality objectives that apply to sediment quality in bays and estuaries. These narrative objectives provide the basis for sediment cleanup activities under current state and federal law.

The section begins with a brief overview of Porter-Cologne and the Clean Water Act, 33 U.S.C. section 1251 et seq. A more detailed discussion of relevant laws, programs, and practices follows. Porter-Cologne is the primary water quality control law for California. It addresses two key functions – planning and waste discharge regulation. The State Water Board adopts state policy for water quality control, which is binding on the Regional Water Boards. (Wat. Code §13140 et seq.) The State Water Board is also authorized to adopt water quality control plans for waters that require water quality standards under the Clean Water Act and must adopt plans for ocean waters and for enclosed bays and estuaries. (Wat. Code §§13170, 131702., 13391.) The Regional Water Boards are required to adopt water quality control plans, or basin plans, for waters within their respective regions. Water quality control plans designate beneficial uses of water, establish water quality objectives to protect those uses, and contain a program to implement the objectives. (*Id.*§13050(j).) The beneficial use designations and water quality objectives (together with an antidegradation policy) constitute water quality standards for purposes of the Clean Water Act. (See Clean Water Act §303(c)(2)(A); 40 C.F.R. §§131.3(i), 131.6.)

The Water Boards have designated for protection a variety of beneficial uses for bay and estuarine waters, including, among others, the preservation and enhancement of fish, wildlife, and other aquatic resources and habitats; commercial and sport fishing; and shellfish harvesting. They have also adopted water quality objectives to protect the uses, which can be either numeric or narrative. All regional basin plans include narrative toxicity objectives.

Porter-Cologne establishes a program to regulate waste discharges that could affect water quality through waste discharge requirements, conditional waivers, or prohibitions. (See Wat. Code §§13243, 13263, 13269.) This program is the principal way in which water quality control policies and plans are implemented. The term "waste" is broadly defined in Porter-Cologne and includes toxic pollutants, as well as other waste substances. (*Id.* §13050(d).) The term "waters of the state" is similarly broadly defined to include all surface waters, including bays and estuaries, and groundwater within state boundaries. (*Id.* §13050(e).)

Porter-Cologne also authorizes the Water Boards to investigate water quality and to require waste dischargers to submit monitoring and technical reports. (*Id.* §13267, 13383.) In addition, Porter-Cologne gives the Water Boards extensive enforcement authority to respond to unauthorized discharges, discharges in violation of applicable requirements, discharges that cause pollution or nuisance, and other matters. The enforcement options include, among others, cleanup and abatement orders, cease and desist orders, and administrative civil liability orders. (*Id.* §13301, 13304, 13323.)

In 1989, Porter-Cologne was amended to specifically address the threat posed to bays and estuaries from toxic pollutants. The legislation, which added chapter 5.6 to Division 7 of the Water Code, mandated that the State Water Board develop a consolidated toxic hot spot cleanup plan and adopt sediment quality objectives for bays and estuaries. The State Water Board established the Bay Protection and Toxic Cleanup Program to implement the requirements of chapter 5.6.

The Water Boards also implement the federal Clean Water Act. As required under section 303(c) of the Act, the Water Boards adopt water quality standards for waters of the United States. In addition, the Water Boards issue National Pollutant Discharge Elimination System (NPDES) permits pursuant to section 402 of the Clean Water Act. Section 402 of the Clean Water Act requires that all point source discharges of pollutants to waters of the United States be regulated under a permit. The State Water Board is the state water pollution control agency for all purposes stated in the Clean Water Act. (*Id.* §13160.) As such, the State Water Board is authorized to issue water quality certifications under Clean Water Act §401 . The Water Boards also implement the total maximum daily load (TMDL) program, which is required under section 303(d) of the Clean Water Act.

4.1 EXISTING WATER QUALITY STANDARDS RELATED TO SEDIMENT QUALITY

As explained above, water quality standards consist of beneficial uses, criteria (which are the federal equivalent of water quality objectives) and an antidegradation policy. All basin plans for the coastal regions contain water quality objectives or prohibitions that apply to sediment quality. None of the Regional Water Boards has adopted numeric water quality objectives for sediments. Rather, the Regional Water Boards typically rely on narrative toxicity objectives to protect and manage ambient sediment quality. The current narratives and prohibitions used to regulate sediment quality are listed below in Section 4.1.1. These narratives (and associated beneficial uses) provide the bases for permit requirements, cleanup actions, Clean Water Act §303(d) listings, and other regulatory activities. Section 4.1.2 explains how the Regional Water Boards currently assess sediment quality to ascertain compliance with water quality standards. Section 4.1.3 describes state policies and federal regulations for toxic pollutant standards applicable to bay and estuarine waters.

4.1.1 Applicable Basin Plan Narrative Objectives or Prohibitions

Water Quality Control Plan for the North Coast Region
Regional Water Quality Control Board 5550 Skylane Blvd., Suite A Santa Rosa, CA 95403
http://www.waterboards.ca.gov/northcoast/programs/basinplan/bpdocs.html

- *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.*

- *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.*

Water Quality Control Plan (Basin Plan) for the San Francisco Bay Basin
San Francisco Regional Water Quality Control Board, 1515 Clay St. Suite 1400, Oakland, CA 94612
http://www.waterboards.ca.gov/sanfranciscobay/basinplan.htm

- 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.
- *Controllable water quality factors shall not cause a detrimental increase in the concentrations of toxic pollutants in sediments or aquatic life.*
- *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 chronic toxicity in ambient waters. Chronic toxicity is a detrimental biological effect on growth rate, reproduction, fertilization success, larval development, population abundance, community composition, or any other relevant measure of the health of an organism, population, or community. Chronic toxicity generally results from exposures to pollutants exceeding 96 hours. However, chronic toxicity may also be detected through short-term exposure of critical life stages of organisms.*
- *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.*
- *Bottom deposits or aquatic growths to the extent that such deposits or growths cause nuisance or adversely affect beneficial uses*
- *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.*

Water Quality Control Plan for the Central Coastal Basin
Central Coast Regional Water Quality Control Board, 895 Aerovista Place Suite 101 San Luis Obispo, CA 93401
http://www.swrcb.ca.gov/rwqcb3/BasinPlan/Index.htm

- *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 Board.*

- *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.*

Water Quality Control Plan Los Angeles Region
Los Angeles Regional Water Quality Control Board 320 W. 4th St Suite 200 Los Angeles, CA 90013
http://www.waterboards.ca.gov/losangeles/html/meetings/tmdl/Basin_plan/basin_plan_doc.html

- *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*
- *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*

Water Quality Control Plan for the Sacramento and San Joaquin River Basins
Central Valley Regional Water Quality Control Board
Sacramento Main Office 11020 Sun Center Drive Suite 200 Rancho Cordova, CA 95670-6114
Fresno Branch Office 1685 E Street Fresno, CA 93706-2007
Redding Branch Office 415 Knollcrest Drive, Suite 100 Redding, CA 96002
http://www.waterboards.ca.gov/centralvalley/available_documents/index.html#anchor616381

- *All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal or aquatic life.*
- *Compliance with this narrative objective will be determined by analyses of indicator organisms, species diversity, growth anomalies, and biotoxicity tests of appropriate duration or other methods as specified by the Regional Water Board.*
- *The Regional Water Board will also consider all material and relevant information submitted by the discharger and other interested parties and numerical criteria and guidelines for toxic substances developed by the State Water Board, the California Office of Environmental Health Hazard Assessment, the California Department of Health Services, the US Food and Drug Administration, the National Academy of Sciences, the US Environmental Protection Agency, and other organizations to evaluate compliance with this objective.*
- *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*
- *Where compliance with these narrative objectives is required (i.e., where the objectives are applicable to protect specified beneficial uses), the Regional Water Board will, on a case-by-case basis, adopt numerical limitations in orders which will implement the narrative objectives. To evaluate compliance with the narrative water quality objectives, the Regional Water Board considers, on a case-by-case basis, direct evidence of beneficial use impacts, all material and relevant information submitted by the discharger and other interested parties,*

and relevant numerical criteria and guidelines developed and/or published by other agencies and organizations.

- *In considering such criteria, the Board evaluates whether the specific numerical criteria, which are available through these sources and through other information supplied to the Board, are relevant and appropriate to the situation at hand and, therefore, should be used in determining compliance with the narrative objective.*

Water Quality Control Plan Santa Ana River Basin
Santa Ana Regional Water Quality Control Board 3737 Main St., Suite 500 Riverside, CA 92501
http://www.waterboards.ca.gov/santaana/html/basin_plan.html

- *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*

Water Quality Control Plan for the San Diego Basin
San Diego Regional Water Quality Control Board 9174 Sky Park Court Suite 100, San Diego, CA 92123
http://www.waterboards.ca.gov/sandiego/programs/basinplan.html

- 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 Board
- The survival of aquatic life in surface waters subjected to a waste discharge or other controllable water quality factors, shall not be less than that for the same water body in areas unaffected by the waste discharge or, when necessary, for other control water that is consistent with requirements specified in US EPA, State Water Resources Control Board or other protocol authorized by the Regional Board. As a minimum, compliance with this objective as stated in the previous sentence shall be evaluated with a 96-hour acute bioassay
- In addition, effluent limits based upon acute bioassays of effluents will be prescribed where appropriate, additional numerical receiving water objectives for specific toxicants will be established as sufficient data become available, and source control of toxic substances will be encouraged

4.1.2 Current Regional Water Board Approaches for Assessing Whether Sediment Quality Complies with Applicable Standards

Indicators and Interpretive Tools
The type of monitoring and testing currently required by the Regional Water Boards to assess sediment quality varies by region. Each Regional Water Board has the discretion to determine how much information is enough to initiate an enforcement action. To assess direct exposure within the regions, one, two or three lines of evidence, such as sediment chemistry, sediment toxicity and benthic community

analysis may be used to initiate an action. In the Central Valley Region, one line of evidence is adequate justification for an action. The lack of assessment tools has limited the use of bioassessment data in regulatory programs within the Central Valley Region (Bruns et al 2007).

The San Diego Regional Water Board has devoted extensive resources to the assessment of sediment quality in San Diego Bay. Staff typically utilize sediment chemistry, sediment toxicity testing and benthic community analysis to assess direct effects to aquatic life. The selection of interpretative tools and thresholds are site specific and typically involve input from other organizations such as California Department of Fish and Game (DFG), U.S. Fish and Wildlife Service (U.S. FWS), California Department of Toxics Substance Control (DTSC), and National Oceanic and Atmospheric Administration (NOAA).

In the San Diego Region, sediment quality guidelines used recently to classify chemical concentrations in sediment are ERMs developed for metals (Long et al., 1998), Consensus midrange effects concentration developed for PAHs and PCBs (Swartz, 1999; MacDonald et al., 2000), and Sediment Quality Guideline Quotient (SQGQ) for chemical mixtures (Fairey et al., 2001). When attempting to distinguish localized impacts from regional or waterbody wide disturbances, these data are also compared with reference sites. The statistical procedure used by the San Diego Regional Water Board to identify stations where conditions are significantly different from the Reference Condition consists of identifying station sample values outside boundary established by the 95% prediction limit (PL) reference pool of data for each contaminant of concern. The sediment toxicity tests applied consisted of a 10-day amphipod survival test, a 48-hour bivalve larva development test exposed to the sediment-water interface, and 40-minute echinoderm egg fertilization test exposed to sediment pore water. The results of these toxicity tests are compared statistically to their respective negative controls using a one-tailed Student t-test ($\alpha = 0.05$). Toxicity results were ranked as low, moderate, and high toxicity based upon the magnitude of the response and type and significance of response and exposure (acute versus sublethal, whole sediment versus porewater). Benthic Community was classified as low, moderate, and high potential for benthic community degradation classifications. In this example, the benthic community structure indices at each station were compared to thresholds developed for the Bight'98 Benthic Response Index for Embayments (BRI-E) (Ranasinghe et al., 2003) and to the Reference Condition sample stations.

For the other Regional Water Boards, sediment chemistry is frequently interpreted by comparison with ambient levels or sediment quality guidelines. Sediment toxicity is characterized by a significant difference in mean survival between a sample and the control and if the magnitude of this difference was biologically significant or comparison to a waterbody specific reference envelope or more recent approaches developed to more effectively integrate the response with other lines of evidence. Where benthic community tools have been developed, those applied include the Relative Benthic Index also developed for the BPTCP, the Index of Biotic Integrity (Thompson and Lows, 2004) and the Benthic Response Index (Smith *et al*, 2003) utilized by Regional Boards, the regulated community, SCCWRP and others to monitor the southern California Bight.

Monitoring

The Regional Water Boards have varying approaches to sediment monitoring. Resolution 92-043 adopted by the San Francisco Bay Regional Water Board on April 15, 1992 officially established the Regional Monitoring Program (RMP) in San Francisco Bay. Resolution 92-043 authorized Regional Board staff to suspend some site-specific monitoring requirements for permittees, if the permittees would contribute to the development and support of a regional monitoring program. The Regional Board recognizing the advantages of a regional program cited the cost effectiveness and the greater ability to assess both the effectiveness of controls and overall waterbody health in comparison to data only collected from specific discharges. A component of includes sediment quality monitoring

Within the Los Angels Region, the City of Los Angeles' Terminal Island Treatment Plant , which discharges into the Los Angeles Long Beach Harbor, is required to perform both routine sediment quality monitoring and to participate in Regional Monitoring Studies. The routine monitoring studies are curtailed while regional monitoring studies are ongoing. Both of these efforts utilize sediment chemistry, sediment toxicity testing and benthic community analysis in addition to other indicators (trawls, tissue residue analysis) (For more information visit http://63.199.216.5/webdata/data/docs/2171_R4-2005-0024_MRP.pdf). Recently the Los Angeles Region has required five permittees to perform a joint sediment characterization study in Marina Del Rey in support of TMDL development. This monitoring program will be used to determine if the controls such as BMPS are effective alone or if sediment remediation will be required in addition to the controls to restore beneficial uses.

4.1.3 Toxic Pollutant Standards

Regulation of toxic pollutant discharges to bay and estuarine waters is important because these discharges can adversely affect sediment quality. In addition to the narrative objectives listed above, state water quality standards include numeric water quality objectives for toxic and other pollutants in water quality control plans and federally-promulgated criteria for toxic pollutants, which are contained in the California Toxics Rule. (See 40 C.F.R. §131.38.) The California Toxics Rule (CTR) criteria apply to inland surface waters, enclosed bays, and estuaries in the state. The numeric criteria and objectives establish permissible water column concentrations for the affected pollutants.

The State Water Board may also consider adopting a policy establishing a water quality objective for methylmercury in fish tissue in the future. In 2001, U.S. EPA issued a recommended fish tissue criterion for methylmercury. The State Water Board's proposed policy would modify the recommended criterion to reflect California-specific information on fish consumption. Elements of the proposed policy may include a methylmercury fish tissue objective, a total mercury water quality objective, a methylmercury water quality objective, or some combination of these objectives. The proposed policy may also include implementation procedures related to the NPDES permitting process.

In 2000, the State Water Board adopted state policy for water quality control to implement toxic standards in bays, estuaries and inland surface waters. The policy, entitled "Policy for Implementation of Toxic Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California," (SIP) provides a standardized approach for permitting discharges of toxic pollutants to non-ocean surface waters in a manner that promotes statewide consistency. The SIP describes: (1) applicable priority pollutant criteria and objectives; (2) data requirements and adjustments; (3) the identification of priority toxic pollutants requiring water quality-based effluent limitations; (4) the calculation of effluent limitations; (5) appropriate translators for metals and selenium;(6) factors to consider in the designation of mixing zones and dilution credits (7) ambient background concentrations and (8) intake water credits.

The SIP is not applicable to stormwater discharges nor does the SIP address sediment quality specifically. However, Section 1.4.2.1 does prohibit mixing zones from causing "objectionable bottom deposits" (SWRCB, 2000). This term is defined as "an accumulation of materials … on or near the bottom of a water body which creates conditions that adversely impact aquatic life, human health, beneficial uses, or aesthetics. These conditions include, but are not limited to, the accumulation of pollutants in the sediment."

Additionally, the State Water Board's "Water Quality Control Policy for the Enclosed Bays and Estuaries of California" prescribes requirements pertaining to toxic pollutant discharges to enclosed bays and estuaries:

- Persistent or cumulative toxic substances shall be removed from the waste to the maximum extent practical through source control or treatment prior to discharge.

- New discharges of municipal wastewaters and industrial process waters (excluding cooling water) to enclosed bays and estuaries (excluding the San Francisco Bay Delta) are prohibited unless the effluent is discharged in a manner that enhances the quality of the receiving water.

4.2 CURRENT SEDIMENT CLEANUP AND REMEDIATION ACTIVITIES

Under current law, sediment cleanup activities may be undertaken in response to a Clean Water Act §303(d) listing, an enforcement order issued pursuant to Porter-Cologne, or the Bay Protection and Toxic Cleanup Program. In addition, cleanup of hazardous wastes may be driven by the California Health and Safety Code well as federal Laws such as Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Superfund Amendments and Reauthorization Act (SARA).

4.2.1 Section 303(d) Activities

State Water Board Listing Policy
Clean Water Act section 303(d) requires that the states list waters that do not meet applicable water quality standards with technology-based controls alone. In 2004, the State Water Board adopted a Water Quality Control Policy for Developing California's Section 303(d) List. For sediments, the policy provides that a water segment will be listed as impaired if the sediments exhibit statistically significant toxicity based on a binomial distribution of the sampling data and exceedances. When applying this methodology, if the number of measured toxicity exceedances supports rejection of the null hypothesis, the water segment is considered impaired. The policy indicates that a segment should be listed if the observed toxicity is associated with a toxicant or toxicants, or for toxicity alone. If the toxicant causing or contributing to the toxicity is identified, the pollutant should be added to the 303(d) list as well.

Appropriate reference and control measures must be included in the toxicity testing. Reference conditions may include a response less than 90% of the minimum significant difference for each specific test organism. Acceptable methods include, but are not limited to, those listed in water quality control plans, the methods used by Surface Water Ambient Monitoring Program, the Southern California Bight Projects of the Southern California Coastal Water Research Project, American Society for Testing and Materials, EPA, the Regional Monitoring Program of the San Francisco Estuary Institute, and the Bay Protection and Toxic Cleanup Program (BPTCP) (SWRCB, 2004b).

Association of pollutant concentrations with toxic or other biological effects should be determined by one of the following (SWRCB, 2004b):

- Sediment quality guidelines are exceeded using the binomial distribution; in addition, using rank correlation, the observed effects are correlated with measurements of chemical concentration in sediments
- An evaluation of equilibrium partitioning or other type of toxicological response that identifies the pollutant that may cause the observed impact; comparison to reference conditions within a watershed or ecoregion may be used to establish sediment impacts
- Development of an evaluation (such as a TIE) that identifies the pollutant that contributes to or caused the observed impact.

TMDLs

Clean Water Act section 303(d) mandates that the state develop TMDLs for its listed waters. A TMDL, in general, identifies the maximum amount of a pollutant that a waterbody can assimilate while still meeting water quality standards. The TMDL identifies pollutant sources and includes an implementation plan that describes the actions necessary to achieve standards, including a schedule and monitoring and surveillance activities to determine compliance. Exhibit 3-10 of the report entitled "Economic Considerations of Sediment Quality Plan for Enclosed and Estuaries in California" (2008) summarizes sediment-related toxic pollutant TMDLs that have already been completed for enclosed bays and estuaries in California. Section 3 of this report identifies bays and estuaries in the coastal regions that are currently on the State Water Board's 2006 Section 303(d) list for water column, tissue and sediment quality impacts associated with toxic pollutants for which TMDLs must be developed.

TMDLs developed by the San Francisco Bay and Los Angeles Regional Water Boards illustrate application of the TMDL program to address sediment quality. The San Francisco Bay Regional Water Board recently adopted a TMDL to address bay-wide exceedances of the narrative bioaccumulation objective caused by excessive methyl-mercury levels. High mercury levels in sediments are due, in large part, to legacy gold mining operations and have resulted in bay-wide fish consumption advisories. The San Francisco Bay Regional Water Board has also listed bay waters for failure to achieve the bioaccumulation narrative objective due to PCBs, another legacy contaminant found in sediments, which was used in many high voltage applications as a dielectric fluid. For both pollutants, the mechanism to restore beneficial uses is through the development of TMDLs where all sources of loading regardless of media are evaluated and controlled to the extent practical. The mercury targets were derived based upon the estimated reduction in mercury mass in tissue that would be needed to be protective of human health and wildlife (California Regional Water Quality Control Board San Francisco Bay Region 2006). Unlike mercury, the movement of PCBs and other hydrophobic organochlorine compounds up through the food web can be predicted with food web models. Once a model has been validated by agreement with actual data, the model can also be used to predict the sediment concentrations that will lower prey tissue to levels that protect the target receptors (California Regional Water Quality Control Board San Francisco Bay Region 2007).

The Los Angeles Regional Water Board adopted the Marina del Rey TMDL in 2005 to address toxic pollutants in sediments and fish tissue. The TMDL established sediment chemistry targets for Marina del Rey, which address both sediment quality and fish tissue. The toxic pollutants include copper, lead, and zinc and chlordane and total PCBs. Numeric targets for these pollutants in sediments are based on ERLs developed by Long *et al* (1995). In addition to sediment chemistry, the monitoring plan includes both acute and chronic toxicity tests as well as fish tissue testing to monitor progress (Technical Committee County of Los Angeles, Chair, 2007). Toxicity tests utilize three marine organisms; 28-day chronic and a10-day acute amphipod mortality test; pore water testing utilizing the sea urchin fertilization test; and the testing of overlying water using the red abalone larval development test. Toxic sediment will be identified by an average amphipod survival of 70% of less. During accelerated testing, if the response average of two tests is less than 90% survival, stressor identification is required.

4.2.2 Cleanup and Abatement Actions

Resolution No. 92-49

In 1992, the State Water Board adopted Resolution No. 92-49, "Policies and Procedures for Investigation and Cleanup and Abatement of Discharges Under Water Code Section 13304," The resolution describes the policies and procedures that apply to the cleanup and abatement of all types of discharges subject to Water Code section 13304. These include discharges, or threatened discharges, to surface and groundwater. The Resolution requires dischargers to clean up and abate the effects of discharges in a manner that promotes attainment of either background water quality or the best water quality that is reasonable if background levels of water quality cannot be restored, considering economic and other factors. In approving any alternative cleanup levels less stringent than background, Regional Boards must apply section 2550.4 of Title 23 of the California Code of Regulations.[12] Section 2550.4 provides that a Regional Water Board can only approve cleanup levels less stringent than background if the Regional Water Board finds that it is technologically or economically infeasible to achieve background. Resolution No. 92-49 further requires that any alternative cleanup level shall: (1) be consistent with maximum benefit to the people of the state; (2) not unreasonably affect present and anticipated beneficial uses of such water; and (3) not result in water quality less than that prescribed in the water quality control plans and policies adopted by the State and Regional Water Boards.

A Regional Water Board must apply Resolution No. 92-49 when setting cleanup levels for contaminated sediment if such sediment threatens beneficial uses of the waters of the state, and the contamination or pollution is the result of a discharge of waste. Contaminated sediment must be cleaned up to background sediment quality unless it would be technologically or economically infeasible to do so.

[12] Resolution No. 92-49, Section III.G.

Examples of Cleanup Actions Related to Sediment Quality

The Regional Water Boards have issued enforcement orders, primarily cleanup and abatement orders, to address violations of narrative water quality objectives related to sediment quality. For example, the San Diego Regional Water Board issued a cleanup and abatement order to Paco Terminals, Inc. in 1985 to require cleanup of copper-contaminated sediments in San Diego Bay. In 1992, the State Water Board revised the order to impose more stringent cleanup levels. (State Water Board Order No. WQ 92-09.) The State Water Board determined that revised cleanup levels were necessary to ensure that sediments did not contain copper levels that would result in exceedance of either numeric water column objectives or narrative objectives for the protection of aquatic life and to comply with Resolution No. 92-49.

Similarly, in 2005, the San Diego Regional Water Board issued a tentative cleanup and abatement order to address discharges of metals and other pollutant wastes to San Diego Bay marine sediments and waters. The tentative order is based, in part, on alleged exceedances of the basin plan's narrative toxicity objectives. Proceedings to consider adoption of the order are ongoing.

Additional examples of ongoing or completed sediment quality related cleanup actions include Castro Cove, Stege Marsh, Moffet Field, Hamilton Air Base Salt Marsh, Peyton Slough in San Francisco Bay and Convair Lagoon, Bay City Marine, Kettenburg and America's Cup Harbor in southern California.

4.2.3 Bay Protection and Toxic Cleanup Program

As stated above, chapter 5.6 mandated that the State Water Board fulfill two key tasks – adopt a consolidated hot spots cleanup plan and develop sediment quality objectives for enclosed bays and estuaries. The State Water Board focused initially on the former task.

4.2.3.1. Consolidated Hotspots Cleanup Plan

Chapter 5.6 Requirements

To address toxic hot spots, Water Code section 13392.5 required the Regional Water Boards to develop a consolidated data base that identified all known and potential toxic hot spot spots. In consultation with the State Water Board, the Regional Water Boards were directed to develop an ongoing monitoring and surveillance program that included suggested guidelines to promote standardized analytical methodologies and consistency in data reporting and identification of additional monitoring and analyses needed to complete the toxic hot spot assessment for each enclosed bay and estuary.

In addition, by January 1, 1998, the Regional Water Boards were required to complete and submit to the State Water Board a toxic hot spot cleanup plan for affected waters within their respective regions. (Wat. Code §13394.) Toxic hot spots are defined in Water Code section 13391.5 (e) "as *locations where hazardous substances have accumulated in the water or sediment to levels which (1) may pose a substantial present or potential hazard to aquatic life, wildlife, fisheries, or human health, or (2) may adversely affect the beneficial uses of the bay, estuary, or ocean waters as defined in water quality control plans, or (3) exceeds adopted water quality or sediment quality objectives*.

Each regional toxic hot spots cleanup plan had to include:

(a) A priority ranking of all hot spots, including the state board's recommendations for remedial action at each toxic hot spot site.
(b) A description of each hot spot site including a characterization of the pollutants present at the site.
(c) An estimate of the total costs to implement the plan.
(d) An assessment of the most likely source or sources of pollutants.
(e) An estimate of the costs that may be recoverable from parties responsible for the discharge of pollutants that have accumulated in sediment.
(f) A preliminary assessment of the actions required to remedy or restore a toxic hot spot.
(g) A two-year expenditure schedule identifying state funds needed to implement the plan.
(h) A summary of actions that have been initiated by the regional board to reduce the accumulation of pollutants at existing hot spot sites and to prevent the creation of new hot spots.

The State Water Board was mandated to submit a consolidated statewide toxic hot spot cleanup plan to the Legislature by June 30, 1999. The statewide plan had to include findings and recommendations on the need for establishing a toxic hot spots cleanup program.

Chapter 5.6 further required the Regional Water Boards to revise waste discharge requirements for dischargers that discharged all or part of the pollutants that caused the toxic hot spot "*to ensure compliance with water quality control plans and water quality control plan amendments, including requirements to prevent the creation of new toxic hot spots and the maintenance or further pollution of existing toxic hot spots."* (Wat. Code §13395.) A Regional Water Board could determine that it was unnecessary to revise waste discharge requirements only if the Regional Water Board determined that the discharger's contribution was insignificant or that the discharger no longer conducted the practices that led to creation of the toxic hot spot. Water Code section 13396 also prohibits any person from dredging or disturbing a toxic hot spot site without first obtaining a water quality certification under Clean Water Act section 401 or waste discharge requirements.

Program Goals and Actions

The BPTCP was driven by four major goals (SWRCB 2004a): (1) protect existing and future beneficial uses of bay and estuarine waters; (2) identify and characterize toxic hot spots; (3) plan for the prevention and control of further pollution at toxic hot spots; and (4) develop plans for remedial actions of existing toxic hot spots and prevent the creation of new toxic hot spots.

The BPTCP identified benthic organisms and human health as the key targets for protection (SWRCB, 1991) and used both exposure and effects-based measurements of the sediment quality triad (sediment toxicity, benthic community structure and measures of chemical concentrations in sediments) and other measures such as biomarkers and tissue residue to identify toxic hot spots. The sediment quality triad coupled with additional lines of evidence formed the basis for making hot spots determinations. The need for multiple lines of evidence was based upon the uncertainty and technical limitations associated with the tools (Stephenson,et al 1994).

Sediment samples were taken only in summer months at a depth of 2-cm below the sediment surface. Evaluation of cause or stressor identification was not included in this program. As a result, biological effects at a site were determined to be associated with toxic chemicals if chemical analysis demonstrated significantly higher levels compared to the reference sites. The Bay Protection and Toxic Cleanup Program Quality Assurance Project Plan (Stephenson,et al 1994) stated that, *because a strict determination of cause-and-effect will not have been achieved, we anticipate that responsible parties will have the opportunity to conduct Toxicity Identification Evaluations as an initial step in site remediation.* The technical team clearly understood the value of stressor identification **preceding** site remediation or restoration, however the difficulty associated with these studies was at the time considered far to expensive to be a requirement (Stephenson,et al 1994).

Consolidated Hotspots Cleanup Plan

The Consolidated Toxic Hot Spots Cleanup Plan (Consolidated Plan) identified and ranked known toxic hot spots, and presented 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 any point and nonpoint source discharges that the Regional Water Boards reasonably determine contribute to or cause the pollution at toxic hot spots. The Consolidated Plan required 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 Consolidated Plan indicated that they are to seek funding from available sources to remediate the site. The Regional Water Boards determined the ranking of each known toxic hot spot based on the five general criteria specified in the Consolidated Plan as shown in Table 4.1. Table 4.2 describes the rank and reason for listing each hotspot identified in the Consolidated Plan.

Table 4.1. 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 (1999).

1. Site rankings are based on an analysis of the sediment chemistry, sediment toxicity, biological field assessments (including benthic community analysis), water toxicity, TIEs, and bioaccumulation.

Table 4.2. 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

Table 4.2. 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 Delta	Aquatic life impacts	Chlordane, Dieldrin, Lindane, Heptachlor, Total PCBs, PAH & DDT
Moderate	Delta Estuary Delta	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, San Francisco Bay	Aquatic life impacts	Mercury, PAHs
Moderate	San Francisco Bay Fruitvale (area in front of storm drain)	Aquatic life impacts	Chlordane, PCBs

Table 4.2. Enclosed Bays Listed as Known Toxic Hot Spots

Rank	Site Identification	Reason for Listing	
		Definition trigger	Pollutants
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 (1999).

As described in Table 4.2 a significant number of hotspots were identified in bays and estuaries. Although the program focused on specific sites, some hotspots encompass large portions of waterbodies and support many of the 303(d) listings described in the previous section. Under the Bay Protection program, all designated hotspots regardless of priority require corrective action, management action or delisting. Appendix D provides additional information on the enclosed bays listed as known toxic hot spots in the Consolidated Plan, including ranking and reason for listing. Appendix D also 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 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.

Depending on the source and areal extent of the known toxic hot spot, the actions to remediate the sites include: (1) Institutional controls/education, (2) Better characterization of the sites and problem, (3) Dredging, (4) Capping, (5) A combination of dredging and capping, (6) Source control, (7) Watershed management, and (8) Implementation of a no-action alternative (natural attenuation).

The estimated total cost to implement the Consolidated Plan ranges from $72 million to $812 million. According to the plan, much of this amount is considered recoverable from responsible dischargers. The un-funded portion of the cost to implement the Consolidated Plan ranges from approximately $40 million to $529 million. Although much of the Consolidated Plan can be implemented through existing Water Code authorities, no funding was obtained to fully implement the Consolidated Plan.

4.2.3.2 SQO Development

In addition to requiring the remediation of toxic hot spots, chapter 5.6 mandated that the State Water Board develop SQOs. The objectives were required for toxic pollutants that had been identified in know or suspected toxic hot spots and for toxic pollutants that the Water Boards had identified as pollutants of concern. The objectives had to be established with an adequate safety margin to reasonably protect beneficial uses and to prevent nuisance. (Wat. Code §13391.5(d).) Further, the objectives had to ensure adequate protection for the most sensitive aquatic organisms. (Wat. Code §13393.) If humans could be exposed to pollutants through the food chain, the objectives had to based on a health risk assessment. (*Ibid.*)

After January 1, 1993, Water Code section 13396 prevents the Water Boards from approving *a dredging project that involves the removal or disturbance of sediment which contains pollutants at or above the sediment quality objectives established pursuant to Section 13393 unless the board determines all of the following:*
(a) The polluted sediment will be removed in a manner that prevents or minimizes water quality degradation.
(b) Polluted dredge spoils will not be deposited in a location that may cause significant adverse effects to aquatic life, fish, shellfish, or wildlife or may harm the beneficial uses of the receiving waters, or does not create maximum benefit to the people of the state.
(c) The project or activity will not cause significant adverse impacts upon a federal sanctuary, recreational area, or other waters of significant national importance.

Funding for the program was provided under former Water Code section 13396.5, which authorized the Water Boards to collect fees from point and nonpoint dischargers that discharged into enclosed bays, estuaries, or adjacent waters to fund the program. The fee period was limited under section 13396.5(h) to January 1, 1998. After that date. the program was no longer fee-funded.

4.2.4 Hazardous Waste Site Cleanups

U.S.EPA , Regional Water Boards and DTSC share responsibility for providing regulatory oversite for the cleanup of hazardous waste sites. The extent of site cleanup actions are based upon the desired goals and end uses established for the site, the evaluation of risks to <u>human health</u> and the environment at the site, and the selection of appropriate management alternatives that will reduce the risks to acceptable levels that are consistent with the desired goals and end uses. In order to evaluate existing risks and potential future risks, conceptual models are prepared that identify receptors potentially at risk and the probable exposure pathways. This conceptual model serves as the basis for formulating the human health and ecological risk assessment. At sites where polluted sediments are the primary concern, receptors commonly evaluated include:

- benthic communities exposed directly to pollutants in sediment,
- fish exposed directly to pollutants in sediment or indirectly through consumption of pollutants in prey tissue or
- birds, marine mammals and humans also exposed indirectly through consumption of pollutants in prey tissue.

For many receptors, risk is estimated by comparing pollutant concentrations in sediments and prey tissues to calculated risk thresholds developed specifically for those receptors. For other receptors, such as benthic invertebrates, direct measurements such as benthic community metrics, sediment toxicity and chemistry may be applied instead. Typically, those most sensitive receptors identified will become the focus of the remedial effort. Water quality objectives may be utilized to assess where the objective is based upon the receptor of concern and reflects the appropriate exposure pathway. However many aquatic life and human health based water quality objectives were not derived to protect these receptors from the exposure pathways that exist at the site such as trophic transfer and bioaccumulation (U.S EPA 1985). Although risk assessments may guide the development of appropriate cleanup targets, the targets must comply with State Water Board Resolution No. 92-49.

4.3 MAINTENANCE AND NAVIGATION DREDGING

Dredging to maintain ports and waterways generates approximately 300 million cubic yards of material annually that requires characterization and disposal (U.S. EPA 1998). Maintenance dredging differs from sediment quality assessments described above because the goal of the programs is to maintain safe navigation. For dredging projects, the assessment is performed in order to identify appropriate disposal sites and controls that may be required to minimize environmental impacts associated with the disposal. Dredge materials are also characterized differently than ambient surface sediments. When assessing dredge materials, often only a small percentage of the material slated for disposal is present as surficial sediment. As a result, dredged materials characterization requires samples collected from multiple depths to adequately characterize the material.

4.3.1 Clean Water Act Section 404/MPRSA

There are three principal acts for the federal regulation of dredging and disposal operations in the United States. These are the Clean Water Act , the Marine Protection Research and Sanctuaries Act (MPRSA) and the Rivers and Harbors Act (RHA). Only the Clean Water Act and MPRSA prescribe the need to assess the quality of the sediment for disposal purposes.

The discharge of dredged or fill materials into "waters of the United States" is regulated under Section 404 of the Clean Water Act. Under section 404, applicants are required to seek permits from the U.S. Army Corp of Engineers (USACE) for proposed discharges of dredged material into waters of the U.S. with concurrence by U.S. U.S. EPA. Under Section 404, U.S. EPA and USACE have jointly developed an effect-based testing program to assess the suitability of dredged materials for inland waters in the USACE/U.S. EPA. Document titled "Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. – Inland Testing Manual (1998) commonly referred to as the Inland Testing Manual or ITM. USACE/U.S. EPA. 1998. The ITM utilizes a tiered, effects-based evaluation scheme to determine the suitability of dredged material for aquatic placement or disposal. Unlike other programs that only assess surficial sediments, dredge materials characterization requires that the sediment be evaluated to the anticipated maximum depth of the proposed activity. Therefore, none of the tools adopted in this program are depth dependent.

The ITM recognizes three distinct exposure pathways for a suitability determination

1. Water column toxicity
2. Benthic toxicity
3. Benthic bioaccumulation

Suitability determinations for aquatic discharge of dredged material take into account not only the technical sediment test results from the ITM, but also the characteristics of the individual disposal sites and the practicability of alternatives to aquatic disposal (including beneficial reuse alternatives).

Tier I of the suitability determination consists of gathering all available chemical, biological, and physical data and information on the source area or waterbody. The information is assessed relative to the characteristics of the disposal site. If enough information is available, a suitability determination can be made within Tier 1 without the need for additional testing. If insufficient information is available, the suitability determination would proceed to Tier 2.

The ITM requires Tier II to evaluate the potential for the disposal to cause an exceedance of water quality standards and the potential for the disposal to impact benthic organisms. To assess the potential exceedance of water quality standards outside the mixing zone, either a numerical mixing model or the chemical analysis of the sediment or elutriate are utilized. The Theoretical Bioaccumulation Potential (TBP) is used to screen potential impacts to benthic organisms. The TBP is a product of the chemical concentration in the sediment normalized to total organic carbon, the biota sediment accumulation factor, and the lipid content of the test organism. This result is compared to the results from a reference site.

The focus of Tier III is on toxicity and bioaccumulation tests. Water column toxicity is evaluated by exposing a sensitive test organism to the elutriate. To make a suitability determination, the LC50 or EC 50 concentrations are assessed after allowing for dilution/mixing to determine if there is potential for water column toxicity. Toxicity of the sediment is evaluated by exposing a benthic organism to the bulk sediment. Sediment toxicity suitability is based on comparison to a reference site. Results from the 28-day bioaccumulation are compared with accepted human health benchmarks such as those published by the Food and Drug Administration.

Tier IV is a more rigorous and site-specific evaluation of toxicity and bioaccumulation. This could include using tests of longer duration, or using other sensitive species and endpoints. Although Tier IV provides the greatest flexibility, the staff from USACE, U.S. EPA and the State must approve the proposed approach, test methods, and corresponding analysis before this study can be initiated.

None of the methods or analyses described in the ITM are intended to assess the quality of bedded undisturbed surface sediments, rather the methodology was developed solely to assess the risk associated with disposal.

Ocean disposal is not regulated under the Clean Water Act, these actions fall under the MPRSA. Section 103 regulates transportation of dredged material for the purpose of ocean disposal (i.e., outside the three mile baseline). Under the MPRSA, the U.S. EPA has the lead in the designation of suitable disposal sites and the USACE in consultation with U.S. EPA issues the permit. Since ocean disposal by definition falls outside state jurisdiction, the state generally has limited regulatory authority for permitting disposal under MPRSA. Like the ITM, the Ocean Testing Manual or OTM is also based upon a tiered, effects-based evaluation scheme to determine the suitability of dredged material for aquatic placement or disposal. The tiered scheme follows the same general approach and methodology utilized for the ITM. The OTM is also not intended for uses to assess the quality of bedded surface sediments.

Under the Clean Water Act there is an allowance for greater flexibility with the level of information required differing for different regions of the country. Differences in the regional implementation of the 404 requirements exist between Northern and Southern California as to the extent and nature of information required. In Northern California for example, suitability determinations for in-bay disposal in San Francisco Bay generally require solid and suspended phase toxicity data but rarely require information on bioaccumulation. In both Northern and Southern California, if an area proposed for dredging has been tested within the past 3 years, then there is an allowance for a "Tier I exclusion with confirmatory sediment chemistry" which means the material is exempted from any effects-based testing so long as the sediment chemistry is similar to what previously has been deemed suitable based upon results of earlier testing.

In Southern California, there are fewer options for a Clean Water Act section 404 disposal (i.e., most material is either ocean disposed under MPRSA, used beneficially for beach replenishment, or managed upland). Material being placed beneficially for beach nourishment generally does not require bioassay testing because only clean materials with grain size compatible with the proposed receiver site are eligible for beach replenishment. The clean sands typically required for stability in high energy environments have little or no ability to bind with pollutants because of the low organic carbon content and limited binding capacity of the minerals that make up most sand size particles.

When there are opportunities for confined or unconfined in-water placement at areas other than approved ocean disposal sites, the Corps' and U.S. EPA regulations allow for materials to be excluded from testing if acceptable engineering controls are available to contain potentially contaminated materials, or if the material is of such a large grain size that contaminants should not be present. When material is placed as a nearshore or upland fill and there is a return flow or exchange with water of the U.S., then typically sediment chemistry and possibly elutriate chemistry may be required. In those instances where there is little or no recent information and/or there is a reason to believe that sediment-associated contaminants are present, then a full suite of chemical and sediment toxicity and bioaccumulation testing may be required.

4.3.2 Water Quality Certifications

Clean Water Act section 401 allows states to deny or grant water quality certification for any activity which may result in a discharge to waters of the United States and which requires a federal permit or license. Certification requires a finding by the State that the activities permitted will comply with all water quality standards individually or cumulatively over the term of the permit. Certification must be consistent with the requirements of the Clean Water Act, CEQA, the California Endangered Species Act (CESA), and the State Water Board's mandate to protect beneficial uses of waters of the State.

The State Water Board considers issuance of water quality certifications for the discharge of dredged and fill materials. Clean Water Act section 401 allows the State to grant or deny water quality certification for any activity which may result in a discharge to navigable waters and which requires a federal permit. State Water Board regulations (Cal. Code Regs., tit. 23, §3830 et seq.) provide the regulatory framework under which the State Water Board issues water quality certifications. The Corps may not issue a Section 404 permit if the State denies water quality certification.

In order to certify a project, the State Water Board must certify that the proposed discharge will comply with all of the applicable requirements of Clean Water Act sections 301, 302, 303, 306, and 307 (42 U.S.C. §§ 1311, 1312, 1313, 1316, and 1317). Essentially, the State Water Board must find that there is reasonable assurance that the certified activity will not violate water quality standards. Clean Water Act section 401 requires the water quality certification process to comply with the Clean Water Act section 404(b)(1) Guidelines.

In California, wetlands are also regulated through under Clean Water Act section 401. 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 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).

In March of 2007, the State Water Board circulated a CEQA scoping document announcing the States intent to develop and propose for adoption a Wetland and Riparian Area Protection Policy.

4.4 POINT SOURCES REGULATED UNDER CLEAN WATER ACT §402

As explained previously, the Water Boards issue and administer NPDES permits in California. Under the Clean Water Act, all point source discharges of pollutants to waters of the United States must be regulated under a permit. Thus, all point source discharges of toxic pollutants to enclosed bays and estuaries must be regulated under an NPDES permit.

Under the NPDES permit program, discharges are regulated under permits that contain both technology-based and water quality-based effluent limits. Water quality-based effluent limits are developed to implement applicable water quality standards As discussed in section 4.1 above, applicable water quality standards for toxic pollutants include narrative and numeric objectives and CTR criteria. The State Water Board's SIP addresses the implementation of numeric toxic pollutant criteria and objectives for bay, estuarine, and inland surface waters.

Typical discharges that are regulated under NPDES permits include discharges from publicly-owned treatment works and industrial facilities. In addition, storm water discharges are regulated under the permit program. The following subsection explains the State Water Board's storm water permit program.

4.4.1 Storm Water

The State Water Board has three distinct storm water programs - municipal, industrial, construction- and a fourth that encompasses parts of the other three because of the number, diversity and geographic extent of the discharges. This fourth program, referred to as Caltrans, describes the stormwater permits associated with the California Department of Transportation

Municipal Discharges
The municipal program regulates storm water discharges from municipal separate storm sewer systems (MS4s). Large (Phase I) and small (Phase II) MS4s implement best management practices (BMPs) to comply under the program. BMPs include both source controls and treatment measures. The Clean Water Act and implementing federal regulations require MS4s subject to NPDES permits to reduce pollutants in storm water to the maximum extent practicable (MEP). The regulations require implementation of BMPs to meet the MEP discharge standard. In California, MS4 permits also require permittees to reduce the discharge of pollutants so that water quality standards are met. This is usually accomplished under a storm water management plan (SWMP).

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) and achieve the water quality standards. 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.

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 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 control storm water runoff and the placement of those BMPs. Additionally, the SWPPP must contain a visual monitoring program; a chemical monitoring program for non-visible 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.

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, which would encompass 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 required Caltrans to implement more stringent controls, if necessary, to meet water quality standards.

4.5 NONPOINT SOURCE CONTROL
Under Porter-Cologne, all waste discharges that could affect water quality must be regulated, including nonpoint source discharges of pollution. Nonpoint source (NPS) pollution, unlike point source pollution from industrial and sewage treatment plants,

comes from many diffuse sources. Some types of NPS pollution are 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. NPS pollution may originate from several sources, including agricultural runoff, forestry operations, urban runoff, boating and marinas, active and historical mining operations, atmospheric deposition, and wetlands.

Nonpoint sources in California must be regulated under waste discharge requirements (WDRs), conditional waivers of WDRs, or basin plan prohibitions. However, WDRs need not necessarily contain numeric effluent limits. The state's Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program (NPS Policy) provides guidance regarding the prevention and control of nonpoint source pollutant discharges and enforcement of nonpoint source regulations (e.g., WDRs). In practice, the Regional Water Boards do not usually impose numeric effluent limits on nonpoint pollution sources; rather they primarily rely on implementation of BMPs to reduce pollution.

In 1998, California began implementing 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 Plan is the Clean Water Act and the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA) (SWRCB, 2000), and state law. 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 Plan.

The NPS Program Plan addresses six categories of nonpoint sources including agriculture, forestry, urban areas, marinas and recreational boating, hydromodification, and wetlands/riparian areas/vegetated treatment systems. For each category, the NPS Program Plan specifies management measures (MMs) and the corresponding management practices or BMPs. The NPS Program Plan provides five general goals:

- Track, monitor, assess, and report NPS Program activities
- Target NPS Program activities
- Coordinate with public and private partners in all aspects of the NPS Program
- Provide financial and technical assistance and education
- Implement MMs and associated BMPs

The following sections discuss the objectives and policies relevant to sediment quality for specific NPS sources.

4.5.1 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 over-application of pesticides
- Over-application of irrigation water resulting in runoff of sediments and pesticides (SWRCB, 2006b).

Although wastewater discharges from irrigated land, including stormwater runoff, irrigation tail-water, and tile drainage are subject to regulation under Porter-Cologne,the Regional Water Boards have historically regulated these discharges under waivers as authorized by Water Code section 13269. This section allows the Regional Water Boards to waive the requirement to have waste discharge requirements if it is in the public interest and the waiver is consistent with any applicable water quality control plans. Although waivers are always conditional, the historic waivers had few conditions. In general, they required that discharges not cause violations of water quality objectives, but did not require water quality monitoring.

In 1999, Senate Bill 390 was enacted into law. The law amended section 13269 and required Regional Water Boards to review and renew their waivers, or replace them with waste discharge requirements. Waivers not reissued automatically expired on January 1, 2003.

To comply with SB 390, as well as to control and assess the effects of these discharges, the Los Angeles, Central Coast, Central Valley, and San Diego Water Boards have adopted comprehensive conditional waivers. An estimated 80,000 growers, who cultivate over 9 million acres, are subject to conditional waivers in the Central Coast, Los Angeles, and Central Valley regions. These Regional Water Boards have made significant strides to implement their waiver programs and are committed to continue their efforts to work with the agricultural community to protect and improve water quality. The number of acres and agricultural operations will increase as other Regional Water Boards adopt conditional waivers for discharges from irrigated agricultural land. The North Coast, San Francisco Bay and Lahontan Water Boards have no immediate plans to adopt waivers for agricultural discharges, but may do so eventually to implement TMDLs. The Santa Ana Water Board is in the process of developing a conditional waiver for discharges from irrigated agricultural lands.

In conjunction with the conditional waivers, Regional Water Boards regulate agricultural discharges from cropland under NPS 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.

To address local issues, the Regional Water Boards adopted conditional waivers that use different regulatory models, as follow:

Central Coast Region:

- Requires the submittal of a Notice of Intent (NOI) for each grower;
- Several waiver conditions were based on recommendations developed by an advisory panel of agricultural and environmental representatives, including individual enrollment, education, farm plan development and a checklist of management practices.
- For group and individual waivers, the focus of monitoring is primarily nutrients and toxicity. A region-wide Monitoring and Reporting Program, adopted by the board, includes provision for follow-up monitoring when water quality objectives are exceeded or toxicity is detected.
- Requires 15 hours of training in farm water quality management. The training is funded through grants in some cases, in others education is provided by cooperators throughout region.
- Requires development of farm water quality management plans that address, at a minimum, irrigation management, nutrient management, pesticide management, and erosion control; and implementation of management practices identified in their plans (CCRWQCB, 2006a).

Los Angeles Region:

- Provision for individual growers to participate in a group. Groups will submit one NOI for all documented participants in the group. NOI to discharge for all dischargers includes individual grower description of location, crop type, and management practices. A Monitoring Plan is submitted with NOI;
- Requires the submittal of NOI's for each individual grower that does not participate in an approved group;
- Monitoring can be performed after the Regional Water Board issues a Notice of Applicability (NOA) to participate. NOA is provided within 6 months of NOI submittal;

- Monitoring is conducted twice in wet weather and twice in dry weather for physical parameters, nutrients, and pesticides. Individual dischargers monitor surface water at the end of property. Group dischargers monitor surface water and watershed-wide receiving water;
- A Corrective Action Plan (CAP) with time-specific management modifications is required when routine monitoring shows the basin plan, CTR, or TMDL limits are not attained;
- Requires 8 hours of training in farm water quality management. Annual monitoring plan requires evidence of education.

Central Valley Region:

- Group participation emphasized;
- NOI required of each grower that chooses to acquire an Individual Waiver. For a Group, the coalition submits one NOI on behalf of the participating growers.
- Coalitions required to submit participant lists and update annually
- Two step communication report and then Management Plan request (via Executive Officer) to correct problems.
- Monitoring plan submitted in second year after group receives approval to participate;
- Timeline for compliance with water quality objectives is no later than 10 years.
- The Central Valley does not require education or training.

San Diego Region:

- Conditional Waiver adopted by the R9 Water Board on October 10, 2007 that includes the following requirements
- Operators must perform a self assessment to identify the pollutants present on the site and assess the potential for runoff and/or infiltration to adversely affect the quality or beneficial uses of the waters of the state
- Agricultural and nursery operators must complete at least 2 hours of water quality management related training annually.
- Agricultural and nursery operations must implement MMs/BMPs to minimize or eliminate the discharge of pollutants that may adversely impact the quality or beneficial uses of waters of the state.
- Agricultural and nursery operators must maintain records pertaining to the water quality management efforts for the operation.
- No later than December 31, 2010, agricultural and nursery operations must form or join a monitoring group.
- No later than January 1, 2011, owners/operators of agricultural and nursery operations must file a Notice of Intent, as either an individual operation or as part of a monitoring group, with the San Diego Water Board
- Currently the County Farm Bureau is working with operators to form a region-wide monitoring group with the intent to submit a NOI to the Regional Water Board by December 31, 2010.

4.5.2 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), and the U.S. Forest Service (USFS) Region 5 controls pesticide use.

In addition to the NPS Program MMs, forestry activities are also controlled through WDR and conditional waivers. Recently, Regional Water Boards have adopted conditional waivers for timber harvesting activities, which require compliance with applicable requirements contained in each region's basin plan.

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.

4.5.3 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.

Urban runoff is addressed primarily through the NPDES program, although the State Water Board's NPS Program applies where runoff is not regulated as a permitted point source. The NPDES program supersedes the Water Boards' NPS Program in the areas where there is overlap. As mentioned in Section 4.4.1, NPDES storm water permits typically require implementation of BMPs, which may or may not be similar to the MMs in the NPS Program.

The control of urban NPS 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 NPS 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.

In 1976, the State Legislature enacted the California Coastal Act to provide for the conservation and planned development of the State's coastline. The Coastal Act 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.

4.5.4 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. Sources include poorly flushed waterways, pollutants discharged from boats (recreational boats and commercial boats), and pollutants generated from boat maintenance activities on land and in the water (SWRCB, 2006b). For example, as mentioned in Section 2.1.1, copper is often found in marina sediments due to the leaching of antifoulant paints.

There are many planned, on-going, and completed activities related to NPS pollution in marinas. The primary focus of these activities is to prevent discharges of waste oil, sewage, petroleum, solid waste, and hazardous substances from surface runoff, improper boat cleaning/maintenance activities, lack of disposal facilities, or improper maintenance of facilities at marinas. The state relies 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).

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 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.

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.

Obstacles facing the implementation of BMPs related to MMs for marinas can be primarily attributed to the insufficiency of the number of regulatory or inspection authorities relative to the number of registered boats and marinas, as well as other budgetary constraints that affect marina programs and activities. There are nearly 1 million registered boats and approximately 650 marinas in California. Marinas and boaters fall under the jurisdiction of multiple State and local agencies. In many cases, marina facilities are not being regulated and are rarely inspected. NPS pollution in marinas is often seen as a low priority for many regulatory agencies, and boating enforcement actions have primarily been in the area of boater safety (SWRCB, 2004a).

4.5.5 Abandoned and Active 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 clean up their sites. The main barrier to a comprehensive program for abandoned mines is liability. Under the federal Clean Water Act, 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 Clean Water Act.

In June 2000, the Department of Conservation (DOC) inventoried the number of abandoned mine sites in California. 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 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, CERCLA, and RCRA 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, 2003). In addition, the Bureau of Land Management (BLM) has an extensive abandoned mine land program.

All active mining projects must comply with the 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 Clean Water Act section 401 Water Quality Certification Program.

4.5.6 Atmospheric Deposition

Atmospheric deposition may be a potential NPS 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, Sabin (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 the Los Angeles Region (LARWQCB 2005a, 2005b), loadings associated with indirect atmospheric deposition are included in the storm water waste load allocations. Therefore, NPS 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 NPS pollution (for example, see LARWQCB, 2005a and LARWQCB, 2005b).

Currently, there are no policies in California to directly address potential NPS pollution from atmospheric deposition. Atmospheric deposition is also not directly addressed in the NPS Program Plan, and only MM 2G (Fire Management) would address possible pollution of PAHs from forest fires.

5. ISSUES AND ALTERNATIVES

This section describes the major policy related issues identified and alternatives that have been considered by staff during the development of a Draft Part 1. Each issue analysis contains the following sections:

Issue: The subject matter or brief question framing the issue followed by an explanation or description of the issue and concerns.

Issue Description: A description of the issue or topic and (if appropriate) any additional background information, list of limitations and assumptions, descriptions of related programs or other information.

Baseline: A description of how the State and Regional Water Quality Control Boards (Regional Water Boards) currently act on the issue.

Alternatives: For each issue or topic, at least two alternatives are provided for consideration. Each alternative is evaluated with respect to the program needs and the appropriate sections within Division 7 of the California Water Code (CWC). For those issues that address scientific questions, the SQO Scientific Steering Committee's position is also stated.

Staff Recommendation: In this section, a recommended alternative (or combination of alternatives) is identified and proposed for adoption by the State Water Board.

Example Language: Following each recommendation, the reader is directed to proposed language in the Draft Part 1 presented in Appendix A where applicable. Presented in Appendix C is the analysis of a data set as applied using the indicators and thresholds described in this Draft Part 1.

5.1 PROJECT ALTERNATIVES

5.1.1 No Project Alternative

CEQA requires that the State Water Board consider the "No-Project" alternative. As explained in Section 4 above, the basin plans for all coastal regions have narrative water quality objectives or prohibitions that apply to sediment quality. These objectives currently provide the basis for Clean Water Act section 303(d) listings, cleanup orders, and other regulatory actions. If this project is not adopted, the assessment of sediment quality does and would continue to occur; however, the lines of evidence, test organisms, community indices and data reduction and analysis would continue to differ significantly by Region. These factors not only limit consistency amongst the regions, but also lower the confidence in, and technical basis for, these assessments. The No-Project" alternative does not comply with the mandate in chapter 5.6 or the judgment against the State Water Board for failure to comply with the mandate.. The "No Project" alternative would not achieve the objectives of the proposed action. Additional discussion of this alternative is presented in Section 6.

> **Alternative 1:** Adopt the no project alternative. As state above the "No Project" alternative would not achieve the objectives of the proposed action.
> **Alternative 2:** Do not adopt the no project alternative.

Staff Recommendation: Alternative 2
Proposed Language: See Appendix A,

5.1.2 What Issues should the draft Part 1 address

At a minimum, the State Water Board is required to comply with the procedures in CWC §§13240 through 13247 in adopting SQOs. Section 13241 lists the factors that the State Water Board must consider when adopting water quality objectives, and section 13242 specifies the elements that must be included in a program to implement the objectives. State Water Board staff believes that sediment quality protection is significantly different from the tools and methods commonly applied to develop water column-based objectives. Therefore, additional information and implementation guidance should be provided to foster greater understanding and consistency when the SQOs are applied within the various regions.

> **Baseline**: Not applicable.
> **Alternative 1:** Include only the SQOs and tools and thresholds needed to implement the objectives.
> **Alternative 2**: Include the narrative objectives and tools and thresholds needed to implement the objectives, and provide a framework that will better support the restoration of sediment quality and beneficial uses.

Staff Recommendation: Alternative 2.

Proposed Language: See Appendix A, Section I.B.

5.2 APPLICABLE WATERS AND SEDIMENT

5.2.1 Applicable Waters

Chapter 5.6 requires the State Water Board to develop SQOs for bays and estuaries. Since 2003, State Water Board staff and the technical team have been developing SQOs and associated tools and thresholds for specific embayments in California. This focus on San Francisco Bay and enclosed bays south of Point Conception was based upon the large volume of data and an understanding of aquatic communities in these waterbodies. Sediment quality within these bays has been relatively well studied since the late 1980's when the State Water Board initiated the Bay Protection and Toxic Hotspots Cleanup Program. Through this program and others such as U.S. EPA's Environmental Monitoring and Assessment Program (EMAP), the San Francisco Estuary Institute Regional Monitoring Program (RMP), and the Southern California Coastal Water Research Project (SCCWRP) Bight 94, 98, and 03, and various site cleanup and dredging projects, a large volume of coupled biological effects and chemistry data existed for the major embayments in California. The technical team was able to rely on this data to evaluate potential indicators for use in this program and was able to refine each indicator and develop California specific thresholds to assess response. The database created for this program included over 150 studies and approximately 5,000 data points. In comparison, very few coupled data sets are available for all the estuaries, including the Sacramento San Joaquin Delta, San Pablo Bay (an estuary) and enclosed bays such as Morro and Humboldt Bays located on the central and north coast respectively.

The indicators and thresholds developed for bays cannot be applied to estuarine water bodies without undergoing rigorous assessment for a variety of reasons. Chapman et al. (2001) provides a detailed explanation of the fundamental physical and chemical differences between the two types of water bodies. The bioavailability of both hydrophobic organic and inorganic pollutants can be influenced by salinity. Chemical equilibrium may not exist within the highly dynamic environments of estuaries. While many of the organisms present in bays are also found in estuaries, their tolerance to external stressors may vary greatly (Chapman et al 2001). Within bays, even during wet years, the denser salt water can provide protection from osmotic shock to marine benthic organisms while estuarine organisms could be exposed to wide variations in salinity through tidal fluctuations. As result the indicators proposed for use within San Francisco Bay and enclosed bays south of Point Conception cannot be considered as reliable when applied to other water bodies until additional analyses are conducted.

Within estuaries, a different approach could be applied to interpret the narrative objective. This approach would utilize the same indicators as proposed for embayments, but would rely on a reference envelope approach to aid the assessment of sediment quality. The reference envelope approach has been applied most notably in San Francisco Bay (Hunt et al 1998a).

This approach could be proposed for use within north and central coast bays as well. An approach for these bays could also be developed that relies on a combination of indicators developed for use in San Francisco Bay and enclosed bays south of Point Conception with the reference approach.

Baseline: Not applicable.
Alternative 1: Develop SQOs for both bays and estuaries as mandated under chapter 5.6that utilize the same conceptual approach for all bays and estuaries, but relies on less robust interim tools in some water bodies as described above. These tools would be replaced under Phase II of the SQO program by more robust indicators and thresholds. This alternative is consistent with the Water Boards' negotiated settlement with the litigants associated with the original lawsuit described in Section ~~1.3~~ 1.2.
Alternative 2: Develop SQOs and an implementation policy for bays first, followed by estuaries in a phased approach. This alternative would not fully comply with the negotiated settlement agreement approved by the Court.

Staff Recommendation: Alternative 1.

Proposed Language: See Appendix A, Sections II.B and V.C.

5.2.2 Applicable Sediments

Sediment quality programs are designed for specific needs. For example, dredged materials are frequently evaluated by collecting samples from multiple depths. This is performed because the properties of the sediment differ at depth, and characterization of the entire volume proposed for dredging is required before an appropriate disposal site can be selected (USACE/U.S. EPA. 1998). For dredged materials characterization, the USACE in coordination with U.S. EPA has designed a series of methods and tools that can be applied to deep sediments to assess risk associated with these materials relative to the disposal sites.

The State Water Board is most concerned with those pollutants that have the greatest potential to harm beneficial uses. Within contaminated sediments, the most direct exposure pathway for pollutants is through surficial sediments or the biologically active layer. In these surficial sediments, the presence of pollutants has the greatest potential to affect valuable and sensitive receptors either through direct exposure or indirectly as the pollutants in surface sediments are transferred up the food chain to piscivorous fish and birds and finally humans. This pathway was evaluated under the Bay Protection and Toxic Cleanup Program where only the upper two centimeters of sediment were sampled (Stephenson et al, 1994) and is also consistent with the conceptual approach used by Washington Department of Ecology in the regulation of polluted sediments in Puget Sound (WDOE, 1995).

Baseline: Previous assessment conducted through the Bay Protection and Toxic Hotspots Cleanup Program focused on the surficial sediments within the biological active layer. As stated in the Bay Protection and Toxic Cleanup Program Quality Assurance Project Plan, the target depth was designated as the upper two centimeters of sediment (Stephenson et al, 1994).
Alternative 1: Do not identify specific sediments applicable within the proposed Part 1. This alternative would severely limit the effectiveness of the program through inconsistent application of the indicators.
Alternative 2: Surficial sediments only. The tools that have been developed are intended solely to assess the biologically active layer.
Alternative 3: Specify a range of depths. As discussed above, the greatest risk from pollutants is with surficial sediments. Developing additional indicators and thresholds for deeper sediments would not provide enough additional value to offset the additional effort and costs to collect and evaluate this data.

Staff Recommendation: Alternative 2.

Proposed Language: See Appendix A, Sections II.C.

5.3 BENEFICIAL USES AND RECEPTORS

5.3.1 Beneficial uses potentially addressed in the draft Part 1

Chapter 5.6 requires the State Water Board to develop SQOs for the reasonable protection of beneficial uses. The Water Boards are required to protect all beneficial uses designated within each water body. Beneficial uses established for bays and estuaries are identified in Table 1. Within the context of this program, State Water Board staff considered those beneficial uses that met the following criteria.

- o Relationship between the beneficial uses and pollutants in sediment. Some beneficial uses are unaffected by pollutants in sediments. Other beneficial uses are clearly affected by pollutants in sediment but are also highly influenced by natural and anthropogenic water quality factors. Other beneficial uses are linked to pollutants in sediments that have not been considered within the context of this program such as indicator bacteria.
- o Ability to utilize robust indicators to measure the potential risk to each beneficial use.
- o Ability to consistently assess the risk to the beneficial use within the context of a sediment quality regulatory program.

Table 5.1 Beneficial Uses for Enclosed Bays and Estuaries

Beneficial Uses	**Description**
Industrial Service Supply	Uses of water for industrial activities that do not depend primarily upon water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection and oil well repressurization.
Navigation	Uses of water for shipping, travel, or other transportation by private military or commercial vessels.
Water Contact Recreation (1):	Uses of water for recreational activities involving body contact with water where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, waterskiing, skin and scuba diving, surfing, whitewater activities, and fishing, and uses of natural hot springs.
Non-contact Water Recreation (2):	Uses of water for recreational activities involving proximity to water but not normally involving contact with water where water ingestion is reasonably possible. These uses include, but are not limited to, picnicking, camping, boating, tide pool and marine life study, hunting, and sightseeing, or aesthetic enjoyment in conjunction with the above activities.
Ocean Commercial and Sport Fishing	Uses of water for commercial or recreational collection of fish, shellfish, or other organisms in oceans, bays, and estuaries including, but not limited to, uses involving organism intended for human consumption.
Aquaculture	Uses of water for aquaculture or mariculture operations including, but not limited to, propagation, cultivation, and maintenance or harvesting of aquatic plants and animals for human consumption or bait purposes.
Estuarine Habitat	Uses of water that support estuarine ecosystems including, but not limited to, preservation and enhancement of estuarine habitats, vegetation, shellfish or wildlife (e.g., estuarine mammals, waterfowl, shorebirds), and the propagation sustenance and migration of estuarine organism.
Marine Habitat	Uses of water that support marine ecosystems including, but not limited to, preservation or enhancement of marine habitats vegetation such as kelp, fish, shellfish, or wildlife habitats (e.g., marine mammals, shorebirds).
Preservation of Biological Habitats of Special Significance	Includes uses of water that support designated areas or habitats such as established refuges, parks, sanctuaries, ecological reserves, or Areas of Special Biological Significance where the preservation or enhancement of natural resources requires special protection.
Rare Threatened or Endangered Species	Uses of water that support habitats necessary for the survival and successful maintenance of plant or animal species established under State/or federal law as rare, threatened, or endangered.
Migration of Aquatic Organism	Uses of water that support habitats necessary for the migration, acclimatization between freshwater and salt water, and the protection of aquatic organism that are temporary inhabitants of waters within the region.
Spawning, Reproduction and/or Early Development	Uses of water that support high quality aquatic habitats suitable for the reproduction and early development of fish.
Shellfish Harvesting	Uses of water that support habitats suitable for the collection of crustaceans and filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption and commercial or sport purposes

The beneficial uses that best meet these criteria consist of Marine and Estuarine Habitat, Commercial and Sport Fishing, and Rare and Endangered Species. All of these beneficial uses can be severely affected by pollutants in sediment and assessed using the indicators described in the following Section.

> **Baseline**: Not applicable.
> **Alternative 1**: Attempt to develop SQOs indicators and thresholds to assess the health of all beneficial uses including Municipal, Industrial, Water Contact Recreation Non-contact Water Recreation and spawning reproduction and or early development.
> **Alternative 2**: Beneficial uses linked to specific receptors (Examples: Marine and Estuarine Habitat, and Commercial and Sport Fishing).

Staff Recommendation: Alternative 2.

Proposed Language: See Appendix A, Sections III.

5.3.2 Choice of receptors

Selection of appropriate receptors is a critical element of every standards development proposal. U.S. EPA's program to develop sediment quality criteria focused on the protection of benthic organisms (EPA 2003 A and B). Other potential sediment-related receptors include demersal fish, aquatic macrophytes, marine birds, and mammals. Each of these receptors is essential to support a healthy ecosystem. Humans are also potentially affected through the consumption of fish tissue containing contaminant residues. Selecting a receptor as a primary indicator of beneficial use protection is relatively straightforward. For example, human health is an obvious receptor to assess Commercial and Sportfishing. Endangered species such as the least tern could be an appropriate receptor to assess Rare and Endangered Species Beneficial Uses protection. Selection of appropriate receptors to assess risk to other beneficial uses is more difficult because of the broad nature of these beneficial uses (See Table 1). For beneficial uses such as Estuarine Habitat and Marine Habitat, many different receptors could be applied. Within the context of this program, receptors were considered based upon the following criteria:

- Ecological Importance.
- Potential for direct or significant exposure.
- Strong link to pollutants in sediment.
- Understanding of response to pollutant exposure understood.
- Availability of tools that can reliably measure response.
- Successfully application in sediment monitoring programs within other sediment monitoring programs in the country.

Fish are an important receptor that can be affected by pollutants in sediments and pollutants that bioaccumulate up the food chain. Fish are ecologically and economically important and provide a source of food to many people. Fish are relatively long lived and exhibit a variety of responses to stress. In terms of a sediment specific receptor, fish exhibit many characteristics that limit their utility in a regulatory framework. Many fish are highly mobile, and, as a result, they can avoid highly impacted areas (Gibson et al 2000). Their mobility also limits the ability to qualitatively assess exposure without detailed long-term studies. Mobility within unconfined water bodies such as bays and estuaries also makes it difficult to utilize community attributes as a measure of fish health. Fish populations also respond rapidly to environmental disturbance or habitat changes. External anomalies such as fin erosion, lesions, and external parasites can be more sensitive indicators of contaminant effects than community integrity and have been utilized within monitoring programs by coastal publicly owned treatment works (POTWs) or regional monitoring programs in the Southern California Bight (Schiff et al 2001). However, these effects cannot be directly linked to pollutants in specific sediments without significant and detailed site-specific studies.

Aquatic macrophytes are the most important primary producers and provide stability to the substrate as well as critical habitat for fish and invertebrates. Aquatic macrophytes can respond to pollutants in sediments; however, water quality factors may play a more significant role (Gibson, 2000).

Benthic communities are recognized as the optimal sediment receptor for several reasons. They play a critical role in aquatic ecosystem health because they:

- Digest a significant portion of the organic detritus that settles out in bays and estuaries.
- Significantly enhance sediment mixing and oxygenate deeper sediments that stimulate bacteria-driven biogeochemical processes.
- Create habitat that enhances recruitment for other organisms.
- Provide food for most fish species that utilize bays and estuaries. Waterfowl and wetlands birds also rely on benthic invertebrates as a primary food source.

As an aquatic life indicator of sediment quality, benthic communities also exhibit the following characteristics (Jackson et al 2000, Gibson et al 2000):

- Benthic communities are an in-situ measure of actual conditions and biological effects that *are or have* occurred within surface sediments. Other tools commonly applied such as laboratory toxicity tests are at best surrogate measures that may or may not be reflective of actual conditions.

- Benthic invertebrates typically spend at least one or all life stages in direct contact with bottom sediments and characteristically exhibit limited range or mobility. This long-term exposure scenario allows for sublethal toxic effects to cause subtle changes in community structure. Other receptors such as fish and birds are more difficult to utilize because of their mobility and migratory life histories.

- The great variety of taxa within a healthy benthic community represents many different feeding and reproductive strategies that create a great range in sensitivity or tolerance to pollutants and other stressors. These tolerances can be used collectively to identify relatively subtle community responses above reference conditions creating a very robust tool.

- A variety of tools have been used to support the assessment of benthic community health in addition to community measures. These tools include sediment toxicity tests and empirical sediment quality guidelines (SQGs).

- Benthic communities are used by many State and federal agencies to evaluate the effects associated with impaired sediments, and to assess the effectiveness of mitigation actions. Existing data and assessment tools have been developed for many water bodies throughout the nation. While variability is always a factor when evaluating biological communities, compared to other indicators, the analysis of benthic community data does not rely on complex food web fate and transport studies and models to link a pollutant or stressor to a specific region or trophic level.

The State Water Board is required to protect all receptors associated with a specific beneficial use. However, many receptors are not understood well enough to develop tools and define appropriate thresholds for measuring the health of the receptor, or the linkage to pollutants in sediments is easily overshadowed by other factors. For these situations, ecological risk assessments are an appropriate means to assess the risk to other receptors.

Baseline: Selection of appropriate receptors for the assessment of sediment quality is site or water body specific with the final decision approved by the Regional Water Board.

Alternative 1: Consider all potential receptors including aquatic plants, plankton, and bacteria. In order to protect all receptors, detailed ecological risk assessments would be required for each water body of concern.

Alternative 2: Consider a variety of important and ecologically relevant receptors. The process could focus on only the most sensitive organisms; however, sensitivity is specific only to types or groups of pollutants. As with Alternative 1, the application of different indicators would require extensive use of best professional judgment and is counter to the argument for statewide consistency of assessment tools.

Alternative 3: Consider important, relevant, and understood receptors (benthic invertebrates, and human health) exposed either directly or indirectly to pollutants in sediments. This alternative focuses on those sensitive and ecologically relevant receptors that have been evaluated and applied as sentinel organisms in sediment quality programs throughout the nation. This alternative would utilize the following sediment-related exposure receptor relationships:

1. Benthic communities exposed directly to pollutants in sediment.
2. Human health exposed indirectly through fish and shellfish tissue.

The receptors and corresponding exposures must be clearly described in the policy. The selection of these receptors is not intended to trivialize the importance of other receptors. Receptors such as fish and wildlife are assessed often during the assessment of contaminated sediments through ecological risk assessment. These detailed site-specific studies are the appropriate mechanism to evaluate risk to those receptors not considered within the proposed Part 1. Additional receptors can be evaluated in later phases of the program.

Staff Recommendation: Alternative 3.

Proposed Language: See Appendix A, Sections III. and IV.

5.4 BENTHIC COMMUNITIES EXPOSED DIRECTLY TO POLLUTANTS WITHIN ENCLOSED BAYS

5.4.1 Lines of Evidence

Water quality is routinely assessed based on a single line of evidence (LOE), chemical-specific concentration-based thresholds developed from toxicological studies. A single LOE is appropriate in the water column because the binding effects of other water column constituents are well understood, and the performance of these chemical-specific criteria is reproducible under a variety of conditions (U.S. EPA, 1985, 1991). Moreover, there is a single predominant means for chemical exposure in the water column, transport across the gills. As a result, scientists have been able to integrate this information to describe site-specific bioavailability of chemical contaminants using tools such as the Biotic Ligand Model (Paquin et al, 2002).

Sediment, however, is a more complex matrix that makes establishment of an objective based on chemical concentration alone problematic. There are two primary factors that create this complexity: variations in the bioavailability of sediment-associated contaminants, and multiple pathways of exposure resulting in both direct effects (from contact with the sediment) and indirect effects (as a result of bioaccumulation and transfer to higher trophic levels). Bulk measures of chemical concentration fail to differentiate between the fraction that is tightly bound to sediment and that which is found in interstitial waters and more available for transport across the gill. Further complicating interpretation of chemical data is that transport of chemicals in interstitial waters across the gill is not the only mechanism for exposure, as many benthic organisms ingest the sediment and can uptake chemicals sorbed onto particles. Thus, even chemical measurement approaches that attempt to differentiate interstitial chemical concentrations, such as using equilibrium partitioning models or direct measurement of pore water chemistry, do not fully describe chemical bioavailability in the sediment. Only the bioavailable fraction of pollutant has the potential to alter basic functional processes such as oxygen transfer or reproduction.

Factors that affect bioavailability of contaminants in sediment include the proportion of organic matter, grain size, hydrogen ion activity (pH), and aerobic state, salinity, chemical form of the pollutants, and the composition and mineralogy of the sediment itself (Chapman et al 2001, U.S. EPA 2000A). These factors can create large spatial and temporal differences in pollutant bioavailability within a given region or water body (Chapman et al, 2001, U.S. EPA 2001A).

Assessing the indirect effects of sediment contamination presents additional challenges besides those identified for direct effects. As predators consume many prey throughout their lifespan, bioaccumulative pollutants with an affinity for fatty tissue, such as DDT, polychlorinated biphenyls (PCBs), and methyl mercury can build up to levels many times greater then those observed in lower trophic levels or in the sediment (biomagnification). Numerous studies have demonstrated that the biomagnification of sediment-associated compounds can cause deleterious effects in fish and in wildlife or human consumers of seafood (Beyer et al. 1996). The presence of multiple trophic levels and different types of receptors for effects creates additional complexity and uncertainty in the interpretation of sediment contamination data.

A thorough understanding of fish communities, trophic structure and uptake, and the pollutant contribution from all sources must be assessed in order to quantifiably link sediment and fish tissue contaminant levels. Fish are highly mobile; at a given site, a portion of an organism's contaminant body burden may result from uptake from other locations, or from other sources such as the overlying water column. Although specific case studies indicate that certain contaminants are accumulated from the sediments (Gobas et al, 2002), this could vary on a site-by-site basis. Variation in home range can affect the relative impact of contamination at a specific site as a result of the heterogeneous distribution of chemicals in the sediment. Variations in food web structure among locations can also cause differences in contaminant bioaccumulation (Gobas et al, 2002).

As a result of the factors described above, sediment quality indicators based on pollutant concentrations in sediment have only limited utility when used by sediment managers unless bolstered by effects data such as toxicity and benthic community disturbance (Chapman 1990, Ingersoll et al 2002c, Wenning et al 2002). This limitation is acknowledged in the ecological risk assessment process, where measures of both chemical exposure and effects are required in order to evaluate the potential for adverse impacts due to either the direct or indirect effects of contaminants.

Other LOE applied to sediments also have potential flaws that make them inappropriate for establishment of SQOs when used alone. Toxicity tests improve in some ways on chemical measurements because they integrate the effects of multiple contaminants- even those chemicals that are not routinely measured. These tests measure individual organism responses relative to endpoints such as growth reproduction and mortality. In the hierarchal response scheme toxicity associated with these organism level endpoints should equate to some affect in community assuming that the indigenous and test species are similarly sensitive and similarly exposed. This paradigm formed the basis for water quality control by relying upon sensitive species and bioassays to establish water quality criteria that are protective of more tolerant organisms. Unfortunately the paradigm has never been proven in sediments. As Griffith (et al 2008) states *organism-level effects are predictive to some extent of effects at the community level. However, this relationship is obscured by differences between these methods other than the hierarchical differences in the level of biological organization between their measurement endpoints*. This conclusion is supported by other authors including Chapman (et al 2001, 2002) Ferraro (2002), Griffith (2008) Luoma (1996) and others. A number of factors weaken this relationship including.

- Toxicity test species and species that compose the benthic community have different sensitivities to different contaminants.
- Toxicity tests typically rely on short-term exposures using relatively few species and end points, making it difficult to interpret ecological significance of the results when used alone.
- Toxicity tests do not mimic the sediment structure, the bio-geochemical processes that influence bioavailability and the exposures that occurs in-situ.
- Presence of natural factors such as ammonia, hydrogen sulfide, or physical abrasion can lead to spurious results.

Benthic community condition is a good indicator because the benthos are directly exposed to sediment contamination and are one of the target biological resources the SQOs are intended to protect. However, their use alone is problematic because they are potentially affected by a large number of factors other than chemical contamination. Without chemistry or toxicity data for confirmation, it is difficult to distinguish whether degraded benthic communities resulted from chemical exposure or from physical disturbance, such as an anchor or prop-wash.

Bioaccumulation is also a useful measure, but sediments classified based on only a tissue uptake/bioaccumulation LOE would not account for toxicants that tend not to bioaccumulate in tissues of biota. Most trace metals and polynuclear aromatic hydrocarbons (PAHs) do not bioaccumulate in tissues, so their presence and toxicity would not be accounted for in such an approach. In addition, impacts from readily biotransformed pollutants would not be addressed by this LOE. The measurement of fish or shellfish tissue contamination provides an important measure of potential effects to wildlife or human consumers, but the mobility and varied life histories of the species makes it difficult to associate the effects with sediment contamination in specific locations.

For these reasons, multiple lines of evidence (MLOE) that represent both contaminant exposure and effects are frequently used in sediment assessments. The State Water Board's Bay Protection and Toxic Hotspots Cleanup Program relied primarily on MLOE to make critical decisions regarding management of sediment in bays and estuaries throughout the State (Anderson et, al 1997, 1998, Fairey, R, 1998, Hunt et al, 1998).

Virtually all of the estuarine ambient monitoring programs in this country rely on some form of the sediment quality triad, where chemistry and multiple measures of biological effect are used together to assess sediment quality (Crane, J.L., et al 2000, Ingersoll, C. et al. 2002, MacDonald et al, 2003, U.S. EPA, 1998, 2004). These include the two largest nationwide estuarine monitoring programs, U.S. EPA's EMAP and the National Oceanic and Atmospheric Administration's (NOAAs) National Status and Trends Program, as well numerous regional monitoring programs, including those for the Great Lakes, Puget Sound, San Francisco Bay, Chesapeake Bay, Southern California Bight, Tampa Bay, and New York/New Jersey harbors.

The triad concept has been used and published in the United States, Canada, Australia, United Kingdom, France, the Netherlands, and Brazil, among others. Most regulatory programs, including those that control open water disposal of dredged material, require tests of sediment chemistry, toxicity, and bioaccumulation. Comprehensive ecological risk assessments invariably use a weight of evidence approach from multiple kinds of assays and tests to estimate and manage risks at waste sites. Even the national chemical benchmarks issued by U.S. EPA that rely on one LOE encourage users to apply them in concert with other sediment assessment tools in making management decisions.

While various MLOE approaches have been used to describe and classify sediment quality, they have typically been applied for site-specific or regional assessments. Moreover, MLOE applications are often based on use of BPJ for combining the individual LOE. BPJ will be ineffective for use in SQOs because the expertise of the individuals applying them will vary considerably across the State, and there is a need for statewide consistency in their application. While there is no direct precedent for translation of MLOE into criteria, standards, or objectives, there are some applications that move in that direction from which lessons can be learned. The State of Washington's SQSs have provisions to use chemical, toxicological, and benthic composition data to classify sediments for multiple purposes, including disposal of dredged material. The Tampa Bay Estuary Program has adopted a triad of measures of sediment quality for management purposes there. The States of Minnesota and Illinois, in partnership with the U.S. EPA Assessment and Remediation of Contaminated Sediment (ARCS) Program of the Great Lakes National Program Office, use the triad of measures to assess sediment quality for management in the Great Lakes.

> **Baseline:** Sediment quality assessment programs throughout the nation rely on MLOE to assess impacts to beneficial or designated uses.
> **Alternative 1:** Do not specify LOE.
> **Alternative 2:** Base policy on application of a single LOE. This alternative would base the policy on a single LOE, such as sediment toxicity, chemistry, or benthic community. Such an approach would be very simple to implement; however, any single LOE is affected by confounding factors, measurement errors, and variability and would contradict the approach recommended by U.S. EPA.
> **Alternative 3:** Base policy on application of MLOE. The suite of tools and LOE would be specific to each receptor.

Staff Recommendation: Alternative 3.

Proposed Language: See Appendix A, Sections I.A, V.A and B.

5.4.2 Form of Sediment Quality Objectives

The State Water Board has the option of establishing narrative or numeric objectives, or some combination of the two. In order to implement an approach based upon MLOE, as described above consideration must be given to the importance of each tool. Sediment quality is assessed with a combination of tools and results, in contrast to a numeric water quality objective for which a single specific measurement may be used. Within this approach, a narrative objective can be proposed that can be implemented with a high degree of confidence using a robust suite of tools; the MLOE approach. This approach would also minimize potential conflicts associated with discordant results. In addition, as better tools are developed to support the narrative objectives, these tools could be added as amendments to the plan while maintaining a consistent narrative objective.

> **Baseline:** As described in Section 4 above, basin plans include narrative objectives that apply to sediment quality, as Implementation of the narrative objectives varies from region to region because the Regional Water Boards typically rely on best professional judgment (BPJ) applied on a case-by-case basis. There are no applicable numeric objectives in California that apply specifically to sediment quality.
> **Alternative 1:** Do not adopt SQOs. This alternative would conflict with chapter 5.6, which requires the State Water Board to adopt SQOs.
> **Alternative 2:** Numeric objectives could be developed and proposed for each LOE. However, each numeric objective would need to be integrated into a weight of evidence approach. The numeric objective would be meaningless without the other LOE.
> **Alternative 3:** Narrative objectives could be proposed that would be implemented using MLOE and corresponding thresholds coupled to a logic based data integration process.
> Alternative 4: Numeric objective based upon the integration of data from the three LOE. This alternative would provide greater utility for statistical analysis however until enough data is collected to evaluate the response relationships between the various LOE to create a valid numeric scale, a scientifically defensible numeric cannot be developed.

Staff Recommendation: Alternative 3.

Proposed Language: See Appendix A, Section IV.

5.4.3 Sediment Toxicity

5.4.3.1 Sediment toxicity to support the direct effects of SQO

Sediment toxicity tests are considered an important component of sediment quality assessments (U.S. EPA 2001a, 2004a, 2004b, 2005, Wenning et al 2005). Recent California assessment programs, such as the Bay Protection and Toxic Cleanup Program, and current programs, such as RMP and the Southern California Bight Regional Monitoring Program, use sediment toxicity as one of multiple measures of sediment quality. Much of the testing has employed acute amphipod survival methods using protocols established by U.S. EPA (U.S. EPA 1994). Many of the projects have also included a measure of sublethal toxic effects in sediments using a wide variety of test methods, including long-term growth tests, elutriate toxicity tests, porewater toxicity tests, and tests of toxicity at the sediment-water interface. The Environmental Monitoring and Assessment Program of U.S. EPA has used amphipod acute testing in conjunction with a variety of sublethal methods in different parts of the country (Ringwood *et al.* 1996, Bay *et al.* 1998). The State of Washington has a program for monitoring and assessing sediments that has been in place for nearly two decades using a combination of acute amphipod tests, polychaete growth tests, and modified elutriate testing with invertebrate larvae (Puget Sound Water Quality Authority 1995).

Laboratory toxicity tests consist of exposing test organisms to sediments within a controlled environment. The toxicity test response provides a direct measure of the combined effects of all chemicals present in the sample and can thus indicate the presence of toxic quantities of chemicals that were not detected or analyzed for in a chemical analysis. Because toxicity tests are conducted using sediments from the environment, the results incorporate the effects of sediment characteristics such as organic carbon that can alter the biological availability of the contaminant. The laboratory environment of the toxicity test allows for the control of confounding factors such as salinity, temperature, or dissolved oxygen that may vary in the field, thus permitting a distinction between toxic effects and effects due to natural habitat variability. For these reasons, some have argued that toxicity tests are the only line of evidence that is required to adequately asses sediment quality. Supporting this argument is the concept that a response causing mortality or reduced growth and reproduction in test organisms should translate to affects within resident community, such as decreased diversity and abundance (Griffith (2008). While this concept is logical and studies have demonstrated correlations between toxicity observed in laboratory organisms and community impacts, sediment toxicity tests cannot reliably predict effects to benthic communities (Chapman et al 2001, 2002) (Ferraro (2002), Griffith (2008) Luoma (1996). Factors affecting this relationship are described in Section 5.4.1. The toxicity test result may overestimate or underestimate effects occurring in the field due to variations in the sensitivity of the test organism or to changes in chemical exposure caused by sediment handling in the laboratory.

> **Baseline:** The State and Regional Water Boards have relied upon sediment toxicity tests.
> **Alternative 1**: Do not consider sediment toxicity tests for measuring direct effects.
> **Alternative 2**: Propose sediment toxicity tests for inclusion in the implementation of direct effects narrative SQOs.

Staff Recommendation: Alternative 2.

Proposed Language: See Appendix A, Section V.A.

5.4.3.2 Choice of toxicity tests should be used

The only means by which the State Water Board can maintain a high level of consistency and data quality is by limiting the tests that can be used in this program to those that meet specific criteria. Various methods for measuring sediment toxicity are available. Key differences between tests include: species, life history stage, duration, endpoint, and mode of exposure. Different species vary in their sensitivity to contaminants as a result of physiological differences, body type, and degree of exposure to the sediment. Crustaceans, bivalves, or polychaete worms are commonly used in toxicity tests, and there is no single species that is consistently the most sensitive to all contaminants of interest (Long *et al*. 1990, Burton *et al*. 1996, Anderson *et al*. 1998b, Bay *et al*. 2007a).

Various life history stages, including embryos, juveniles, and adults, are used in toxicity tests (Lamberson *et al.* 1992). Embryos and juveniles are generally more sensitive to contaminants than adults, but adult test organisms may be less sensitive to confounding factors that complicate test interpretation. There are a variety of endpoints that are specific to each test. The simplest endpoint is survival or lethality which is the endpoint associated with acute tests.

Sublethal test endpoints include growth, reproduction, egg fertilization, embryo development, and biochemical responses such as DNA damage or cellular stress.

Test duration varies widely among toxicity test methods; tests generally range from 48 hours to 28 days in length. Longer duration tests may be more sensitive to the effects of chemicals that require bioaccumulation before toxicity is caused, but they also are more difficult and expensive to conduct. The method of exposure can also affect the sensitivity of the toxicity test or the data interpretation. Many tests expose the organism directly to whole sediment, which provides potential chemical exposure from direct particle contact, the pore water, and from sediment ingestion. Other test methods expose the organism to pore water extracted from the sediment, an elutriate, overlying water, or a solvent extract of the sediment (Anderson *et al*. 1996, Carr and Nipper 2003). These variations in exposure method are used to facilitate tests with organisms that cannot tolerate sediment contact (e.g., embryos) or to investigate specific mechanisms of exposure.

Because toxicity test responses are governed by so many different factors, a suite of standard test methods is often used to measure sediment toxicity in various assessment or regulatory programs. By requiring the use of specific test methods, (1) consistency is established throughout the State, (2) statewide thresholds can be developed that minimize subjective decision making, and (3) inappropriate tests will not be performed.

The process of selecting the recommended toxicity methods for the SQO program is described in Bay *et al*. (2007a). A review of the scientific literature and consultation with other scientists was used to identify a set of candidate sediment toxicity protocols that had the following characteristics: adopted or approved by U.S. EPA, USACE, American Society for Testing and Material Standards (ASTM), or other states; tolerance of expected sediment physical characteristics; diversity of taxonomic groups; association between response and sediment exposure; sensitivity to individual contaminants; and representative of benthic community species. The selection process resulted in a candidate test method list consisting of acute methods with the four commonly used amphipod species (*Ampelisca abdita*, *Eohaustorius estuarius*, *Rhepoxynius abronius,* and *Leptocheirus plumulosus*) plus six sublethal methods using amphipods (*Leptocheirus plumulosus),* polychaete worms *(Neanthes arenaceodentata),* sea urchins *(Strongylocentrotus purpuratus),* bivalves (*Mytilus galloprovincialis, Mercenaria mercenaria, Crassostrea virginica*)*,* and copepods (*Amphiascus tenuiremis*)*.* The tests are summarized in Table 5.2 from Bay *et al*. (2007a).

Table 5.2. List of candidate sediment toxicity tests, the citations containing testing protocols and whether quality assurance and test acceptability criteria have been established.

Species	Taxonomic Group	Duration (days)	Matrix	Endpoint(s)	Citations	State or National Program Use[1]
Ampelisca abdita *Eohaustorius estuarius* *Rhepoxynius abronius* *Leptocheirus plumulosus*	Amphipod	10	Whole sediment	Survival	(U.S. EPA 1994, ASTM 1996)	EMAP NOAA USACE WA, RMP

Leptocheirus plumulosus	Amphipod	28	Whole sediment	Growth, reproduction, survival	(U.S. EPA 2001)	
Neanthes arenaceodentata	Polychaete	28	Whole sediment	Growth, survival	(ASTM 2002b) modified	USACE[2] WA
Strongylocentrotus purpuratus	Sea urchin	3	Sediment-water Interface	Embryo development	(Anderson *et al.* 1996)	
Mytilus galloprovincialis	Mussel	2	Sediment-water Interface	Embryo development	(Anderson *et al.* 1996)	RMP
Amphiascus tenuiremis	Copepod	14	Whole sediment	Reproduction, survival	(Chandler and Green 1996)	NOAA
Mercenaria mercenaria	Clam	7	Whole sediment	Growth, survival	(Ringwood and Keppler 1998, Keppler and Ringwood 2002)	
Crassostrea virginica	Oyster	4	Whole sediment	lysosomal stability	(Ringwood *et al.* 1998, Ringwood *et al.* 2003)	

[1]EMAP: Environmental Monitoring and Assessment Program; NOAA: NOAA National Status and Trends Program; USACE (U.S. Army Corps of Engineers: dredged material evaluation for disposal under USACE or U.S. EPA guidance; WA: dredged material evaluation for disposal under Washington State guidance; RMP: San Francisco Bay Regional Monitoring Program

[2]The same species and endpoint is used in dredged material evaluations, but the duration and aspects of the test method differ

Toxicity tests on sediment pore water or elutriate samples were not considered for evaluation because of technical limitations in the methods. Pore water tests are widely used for testing sediment toxicity (Carr and Nipper 2003), but it is difficult to collect enough sample for testing. Other characteristics of pore water toxicity tests make these methods less suited for use in the SQO program, including potential changes in metal toxicity due to oxidation, change in sample pH, sorption of contaminants to test chambers, confounding effects of ammonia toxicity, and elimination of sediment ingestion as a route of uptake (Ho *et al.* 2002). Elutriate tests were also not included in the list of candidate methods. These tests, where sediments are added to water with agitation, allowed to settle, and then the water is removed for testing, are often used for testing the effects of sediment resuspension during dredged material disposal. The elutriate sample is subject to many of the confounding factors associated with pore water, and the relationship of the results to direct sediment exposure is not known. The decision to exclude pore water and elutriate tests was endorsed by the SQO Scientific Steering Committee.

Each of the candidate methods was ranked relative to the following characteristics: organism availability, method documentation, technical difficulty, sensitivity, precision, and cost. Results of these are shown on Tables 5.3 and 5.4. Survival tests using the amphipods *E. estuarius, R. abronius,* and *L. plumulosus* were recommended as the best choices for acute testing in California. *E. estuarius* and *R. abronius* have a substantial history of successful use in California for both monitoring and assessment studies. The *L. plumulosus* 10-day test has been conducted in California on a much more limited basis. However, it has long been used in other parts of the country, especially on the Gulf Coast for monitoring and assessment studies.

Leptocheirus is also easily cultured in the laboratory and available year round from commercial suppliers.

Two sublethal test methods were recommended for use in the SQO program: a 28-day growth test using the polychaete worm *Neanthes arenaceodentata* and a 2-day development test using embryos of the mussel *Mytilus galloprovincialis* exposed at the sediment-water interface. These tests had the best combination of characteristics related to test feasibility, method documentation, and sensitivity. The recommended sublethal tests complement the ability of the acute tests to detect toxicity by providing diversity in test species, length of exposure, and mode of exposure. The other candidate sublethal tests were not recommended for a variety of reasons, including incomplete documentation of the method, high cost, and relatively low sensitivity to contaminated sediments
.

Table 5.3. Characteristics of candidate sediment toxicity test methods from Bay et al (2007a). NA=not applicable for test.

	Organism Availability[1]	Method Description[2]	Technical difficulty[3]	Concordance at clearly clean or impacted sites[4]	More sensitive than *Eohaustorius*[5]	Reproducibility among ~~laboratoriess~~ laboratories[6]	Reproducibility within ~~lababoratoriess~~ laboratories[6]	Relative Precision of response[7]	Documentation of confounding factors[8]	Cost of method[9]
Amphipod Acute										
Eohaustorius	12 (+)	Standard	Low	NA	NA	Good	Good	NA	Good	Low
Rhepoxynius	12 (+)	Standard	Low	NA	Sometimes	Good	Good	NA	Good	Low
Leptocheirus	12 (+)	Standard	Low	NA	Often	Fair	Poor	NA	Fair	Low
Ampelisca	8 (+)	Standard	Moderate	NA	Rarely	Poor	Good	NA	Fair	Low
Sublethal Methods										
Mercenaria growth	8(+)	Published	Low	Fair	Sometimes	Fair	Fair	Similar	Good	Low
Neanthes growth and survival	12(1)	Published	Moderate	Fair	Sometimes	Good	Good	Low	Good	High
Sediment-water interface										
Mussel development	12(++)	Published	Low	Fair	Sometimes	Fair	Good	Low	Fair	Low
Sea urchin development	5(++)	Published	Low	Fair	Rarely	None	Good	Low	Good	Low
Leptocheirus chronic	12(+)	Standard	Moderate	Fair	Sometimes	Fair	Good	Low	Good	High
Copepod life cycle	12(1)	Published	High	Good	Often	None	Good	High	Fair	Very High
Oyster lysosomal stability	8(++)	Report	Moderate	Poor	Rarely	None	None	Low	Poor	Moderate

[1]Number of months (relative number of available suppliers, + +for many, + for few, 1 for one)
[2]Standard=Established method by government agency; Published=Peer reviewed publication of method; Report=In gray literature
[3]Low=Similar skills and equipment needed as for acute amphipod test; Moderate=More difficult to obtain acceptable controls, special techniques or more complex exposure system; High=Combination of special skills and more complex exposure system needed [4]Concordance with acute amphipod test: Good=>75%; Fair=<75%>50%; Poor<50%.
[5]Of the stations found to be toxic by at least one endpoint: Often=>50% of stations; Sometimes=<50%>20, Rarely<20%; Never=0
[6] Good= CV<50%; Fair= CV >50%<75%; Poor=CV>75% (CV= coefficient of variation; mean/standard deviation)
[7]Categories based on the range of median acute amphipod standard deviations. High=below range; Similar=within range; Low=above range
[8]Data available for confounding factors: Good=Four or more factors; Fair= 2 or 3 factors; Poor= Less than 2 factors
[9]Low=150% or less the cost of acute amphipod; Moderate = 150% to 200% of amphipod; High = 200% to 300% of amphipod; Very High = >300% of amphipod.

Table 5.4. Ratings of acute and sublethal sediment toxicity methods from Bay et al (2007a). Total score is sum of ratings

	Feasibility					Performance and Cost							
	Organisms Availability	Method Description	Technical Difficulty	Overall Feasibility		Concordance with amphipods at clearly clean or impacted sites	More sensitive than acute *Eohaustorius* test	Reproducibility among laboratories	Reproducibility within laboratories	Relative precision of response	Documentation of confounding factors	Relative per station cost	Total Score
					Factor	2	4	2	2	1	2	2	
Amphipod Acute													
Eohaustorius	+	+	+	Yes		NA	8	6	6	2	6	6	34
Rhepoxynius	+	+	+	Yes		NA	8	6	6	2	6	6	34
Leptocheirus	+	+	+	Yes		NA	12	4	2	2	4	6	30
Ampelisca	+	+	+	Yes		NA	4	2	6	2	4	6	24
Sublethal Methods													
Mercenaria growth	+	-	+	No		4	8	4	4	2	6	6	34
Neanthes survival and growth	+	+	+	Yes		4	8	6	6	1	6	2	33
Sediment-water Interface													
Mytilus galloprovincialis	+	+	+	Yes		4	8	4	6	1	4	6	33
Strongylocentrotus purpuratus	+	+	+	Yes		4	4	0	6	1	6	6	27
Leptocheirus-28 Day	+	+	+	Yes		4	8	4	6	1	6	2	31
Amphiascus Lifecycle	-	+	-	No		6	12	0	6	3	4	0	31
Crassostrea lysosomal stability	+	-	-	No		2	4	0	0	1	2	4	13

Baseline: The State and Regional Water Boards have used different amphipod species for acute tests within different programs, though *A. abdita* and *E. estuarius* are the species most commonly required. Sublethal sediment toxicity tests are not typically required by State and Regional Water Boards in NPDES programs.
Alternative 1: Do not specify toxicity methods.
Alternative 2: Specify only acute toxicity methods.
Alternative 3: Specify only sublethal toxicity methods.
Alternative 4: Specify a combination of acute and sublethal toxicity methods.

Staff Recommendation: Alternative 4.

Proposed Language: See Appendix A, Section V.F.

5.4.3.3 Evaluation of toxicity test responses

To provide consistent interpretation and assessment of sediment toxicity, Part 1 should describe how the responses to the tests recommended above are assessed. If Part 1 did not include this information, the interpretation of sediment toxicity would have to be decided by individual staff at the Regional Water Boards using best professional judgment, which would create a greater risk of inconsistent assessment both within and across the regions.

Interpretation of sediment toxicity is commonly assessed using a binary approach (nontoxic/toxic) or by using three or more categories to distinguish different levels of response and confidence. The advantage of multiple categories versus the binary approach is that it provides greater information about the toxicity response and thus provides greater potential resolution when combining the toxicity data with other lines of evidence in a sediment quality triad approach. This is especially important when the end user must be able to distinguish not only the highly impacted stations from the unimpacted stations, but also those stations that exhibit low levels of impact as well. For this reason, members of the SSC strongly supported the development of multiple categories for all LOE.

In response to this need, the SQO technical team developed a multi-category system adapted from the three-category system commonly used to classify sediment toxicity (Long et al, 2000). In the three-category system, the test response is classified as nontoxic, marginal, or toxic. Within the SQO program, the technical team developed a system based upon four categories. Each of the four categories was based on a narrative description of condition that incorporated both the degree of confidence that a toxic effect was present and the magnitude of response (Bay et al, 2007).

- **Nontoxic:** Response not substantially different from that expected in sediments that are uncontaminated and have optimum characteristics for the test species
- **Low Toxicity**: A response that is of relatively low magnitude; the response may not be greater than test variability
- **Moderate Toxicity**: High confidence that a statistically significant effect is present

- **High Toxicity**: Highest confidence that a toxic effect is present and the magnitude of response is among the strongest effects observed for the test

The nontoxic and marginal categories used in previous studies such as the Water Boards' Bay Protection Program correspond to the nontoxic and low toxicity categories of the scoring system proposed for here. The category designated as toxic in past studies typically represented a reliably statistically significant response that encompassed a wide range of effects (*e.g.*, 0 – 80% survival) and as a result provided little discrimination among the majority of the toxic samples. The proposed approach described here divides this broad response category into two categories defined as moderate and high, in order to provide the ability to distinguish severe effects from more moderate responses.

Figure 5.1 illustrates the relationship between these four categories, the numeric thresholds and statistical criteria. In order to assess toxicity response within a given sample, the end user would simply compare test results (e.g., % survival) to Low, Moderate, and High thresholds and statistical significance criteria.

Basis for Thresholds

The thresholds were developed using test-specific characteristics, such as test variability (minimum significant difference (MSD)) and distribution of the toxicity response data. A statistical criterion was also used in the classification scheme (Figure 5.1). Samples qualifying for the Low or Moderate categories based on test response magnitude were classified into the next lower category if the response was not significantly different relative to the control (t test, $p \leq 0.05$). A statistical significance criterion was not applied to the highest toxicity category because the derivation of the high toxicity threshold already incorporated a high degree of statistical confidence.

The basis for establishing each of the sediment toxicity thresholds that bound each category is summarized below. The analyses used to derive the thresholds are described in Bay et al. (2007a). This report can be downloaded directly from www.sccwrp.org.

Low Toxicity Threshold

The threshold separating the nontoxic and low categories was defined as the lowest acceptable control response value for the given test, as established in the test protocols. The response value is defined as the mean value for the endpoint for a given test method (i.e. survival, growth). This threshold was based on the rationale that any response that fell within the range expected of animals exposed to optimum sediment conditions (i.e., controls) should indicate a nontoxic condition in the test sample. The control acceptability criteria were obtained from the appropriate protocol for each test method. Any test sample having a response value that is greater than or equal to the low threshold will be classified as nontoxic, regardless of whether a statistical difference from the control is present. A test response that is less than the low threshold will be classified as Low, Moderate, or High, depending on the magnitude of response and statistical significance (Figure 5.1).

Moderate Toxicity Threshold

The intent of the Moderate Threshold is to distinguish between samples producing a small response of uncertain significance and larger responses representing a reliably significant difference relative to the control. This threshold was based on the Minimum

Significant Difference (MSD), which was specific to each test method. The MSD represents the minimum difference between the control and sample response that is necessary to be statistically different at $p \leq 0.05$ level. The moderate threshold was equal to the 90th percentile of the MSD for a given toxicity test method. This approach for calculating a toxicity threshold has been used by other researchers (Phillips *et al* 2001). Use of the 90th percentile results in a threshold with a high degree of confidence that the sample is different from the nontoxic condition.

The MSD values were calculated using the replicate control and sample data from many toxicity tests. Details of this calculation can be found in Phillips *et al.* (2001). For each combination of a control and a sample, the variance of the replicates, number of replicates, and the t-critical value for the pair were used to calculate a single MSD value. All of the MSD values in the dataset for each toxicity test method were then sorted in rank order. The 90th percentile value of this set of data was then calculated (MSD_{90}). The MSD_{90} values were calculated using all available data for each toxicity test method. Finally, the moderate threshold value was calculated by subtracting the MSD_{90} from 100% in order to produce a value that could be compared to the control-adjusted test response value.

Sample response values (i.e. survival or growth) between the low and moderate thresholds are classified as Low Toxicity if they are significantly different from the control response (Figure 5.1). Sample response values that are less than the moderate threshold and are significantly different from the control are categorized as moderately toxic.

High Toxicity Threshold

The intent of the High Threshold is to identify samples producing a severe and highly significant effect from those samples producing lesser effects. No precedent for this threshold was available from the literature, so this threshold was based on a combination of test variability and response distribution that corresponded to the category definition. This approach was recommended by the SQO Scientific Steering Committee.

The 99th percentile MSD value was used to link the High threshold to test variability. A sample having a response that falls below this limit would be expected to be significantly different from the control 99% of the time. This value therefore represents a response that is associated with a very high level of confidence of statistical significance. The 99th percentile MSD for the high threshold was calculated using the same data and methodology described for the calculation of the MSD_{90} for the moderate threshold.

The response distribution component of the high threshold was based on the distribution of toxic samples from California. For purposes of this calculation, toxic samples were defined as samples having a mean response that was significantly different from the control response. The toxic samples were ranked in descending order based on the control-adjusted mean survival. The response magnitude component of the high threshold corresponded to the 75th percentile of the data. The value obtained from this calculation represents the response associated with the most strongly affected 25% of the toxic samples found in California. It was required that data for this calculation be from stations within California in order to obtain a response value that was relevant to the characteristics of sediments in California.

Both the variability and data distribution response values represented important, but partial, aspects of the High Threshold. Therefore, the mean of the two values was used as the High Threshold. Response values (i.e. survival or growth) below the high threshold are classified as high toxicity regardless of whether they are significantly different from the control response or not (Figure 5.1).

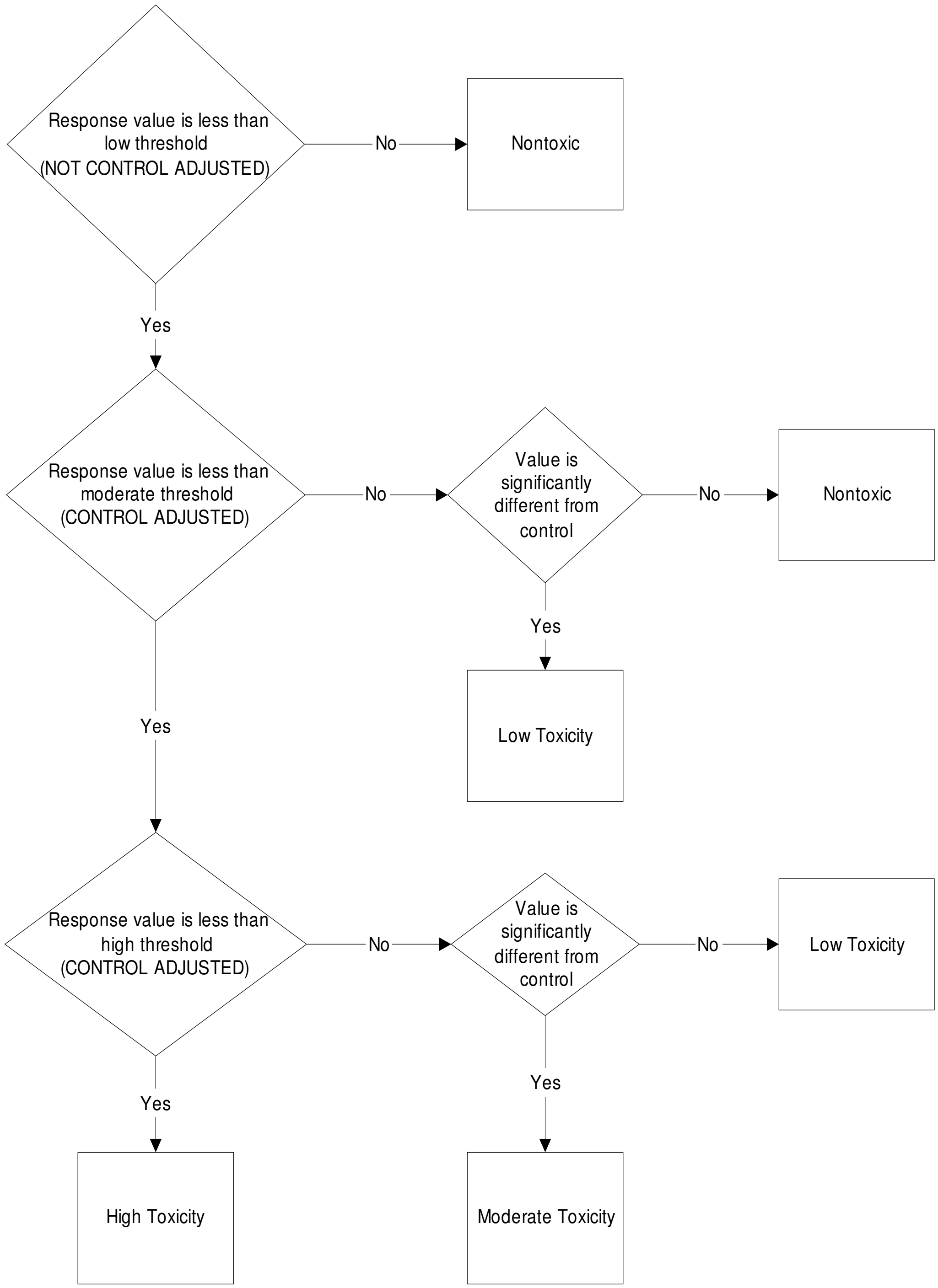


Figure 5.1 Conceptual approach and process for assigning the category of toxicity from laboratory test results.

Sediment Toxicity Thresholds
The toxicity test thresholds developed for the SQO program are summarized in Table 5.5. These thresholds are similar to comparable thresholds utilized within the California Bay Protection and Toxic Cleanup Program and the Southern California Bight Regional Monitoring Programs.

Table 5.5. Proposed toxicity threshold values for the sediment toxicity test methods

Species	Low (%)	Moderate (% Control)	High (%Control)
Eohaustorius	90	82	59
Rhepoxynius	90	83	70
Leptocheirus	90	78	56
Neanthes	90[1]	68	46
Mytilus	80	77	42

[1] % of control growth.

Baseline: Existing programs typically categorize response as either toxic or nontoxic where the toxic response is defined as a reliably statistically significant response that encompasses a wide range of effects (*e.g.*, 0 – 80% survival).
Alternative 1: Categorize toxicity response as toxic or nontoxic
Alternative 2: Categorize toxicity response by the toxicity thresholds identified in Table 5.5.

Staff Recommendation: Alternative 2

Proposed Language: See Appendix A, Section V.F. Presented in Appendix C is an example problem and solution based upon the proposed language.

5.4.4 Chemical Analysis

5.4.4.1 Chemical concentrations used to support the Direct Effects of SQOs

Many monitoring and assessment programs evaluate the effects of chemical contamination on sediment quality. Sediment quality guidelines (SQGs), tools that relate contaminant concentrations to the potential for adverse effects on sediment-dwelling organisms, are often used to help interpret sediment chemistry data. SQGs have been used for over 30 years to assess sediment contamination (Engler *et al.* 2005), yet there are many factors that make their use a complex and challenging task. These complicating factors include a lack of guidance on how to evaluate the many types of SQGs in order to select the approach best suited for a particular application, uncertainty regarding how to assess complex mixtures of contaminants, the inability to reliably predict contaminant bioavailability, and uncertainty in how to establish thresholds for SQG interpretation that define acceptable and unacceptable sediment quality (Wenning *et al.* 2005).

Numerous studies have shown that each type of SQG has predictive ability with respect to biological effects (Wenning *et al*. 2005). The predictive ability is often greatest in instances of high/low contaminant concentrations. Predictions of the biological effect based on SQGs have the highest error rates when applied to samples containing intermediate levels of contamination (Long *et al.* 1998, Fairey *et al.* 2001). The predictive ability of SQGs has also been shown to vary among datasets from different regions (Fairey *et al.* 2001, Crane *et al.* 2002), which complicates the selection of the most reliable approach and thresholds for a given application.

There is considerable concern over the misuse of sediment chemistry guidelines to implement narrative water quality objectives in Basin Plans. The use of chemical SQGs is often accompanied by substantial uncertainty and controversy, as no single SQG approach is able to account for all of the factors that influence contaminant effects. In sediments, if pollutant concentrations are very low or not detected but significant effects are observed, two possible scenarios exist: (1) a non-pollutant-related stressor, such as physical disturbance or habitat alteration, is the cause of impairment; or (2) a pollutant is present that was not identified by the suite of analytical methods selected (Chapman 1990, Ingersoll *et al*. 2001). Both scenarios assume that the effects data and the chemistry data accurately reflect the conditions at the station. Conversely, if pollutant concentrations are elevated but effects are not observed, the pollutant may not be bioavailable. Simple effective approaches to quantify the bioavailable fraction of a pollutant in sediment are not currently available and are not likely to be developed in the near future (U.S. EPA 2005).

> **Baseline**: Sediment chemistry is frequently used as an indicator to assess potential impacts. In this role, sediment concentrations are compared to various SQGs (ERLs, ERMs, PELs, AETs) either independently or in conjunction with other LOEs to determine if the pollutants in sediment pose a risk. In California, there are no current plans or policies that define what guidelines shall be used, how the guidelines should be applied, or what conclusions can appropriately be drawn based solely on chemistry.
> **Alternative 1**: Do not consider sediment chemistry as a direct-effects implementation tool. As described previously, sediment chemistry is not a measure of the bioavailable fraction of pollutants in sediment. As a result, this tool would have little or no utility within a state sediment quality program.
> **Alternative 2**: Propose specific sediment chemistry indicators for inclusion in the implementation of direct effects narrative SQOs. Within the draft policy, sediment chemistry would be proposed as a surrogate measure of exposure and used only with other LOEs.

Staff Recommendation: Alternative 2.

Proposed Language: See Appendix A, Section V.A.

5.4.4.2 Choice of chemistry indicators

There are three principal types of SQGs, based on the approach used in their derivation: empirical, mechanistic, and consensus. Empirical SQGs are the most widely used type; these guidelines are derived from the statistical analysis of large databases of matched sediment chemistry and biological effects data. Examples of empirical SQGs for the marine environment include the effects range-median (ERM) probable effects level (PEL), apparent effects level (AET), and logistic regression models (LRM) (Long *et al.* 1995, MacDonald *et al*. 1996, Barrick *et al*. 1988, Field *et al.* 2002). Mechanistic SQGs take into account chemical and biological processes that affect contaminant bioavailability and toxicity. Current mechanistic SQGs are based on equilibrium partitioning theory and apply to selected classes of contaminants, primarily divalent metals and some types of nonionic organics (U.S. EPA 2004c, 2004d). Consensus guidelines are derived from the aggregation of several types of SQGs having a similar narrative intent (e.g., median effect). Marine consensus SQGs have been developed for a relatively small number of constituents, including metals, PCBs, and PAHs (MacDonald *et al*. 2000, Swartz 1999, Vidal and Bay 2005).

There are two potential applications of chemical SQGs in a SQO policy setting: overall assessment of the presence of impacts due to chemical pollutants, and determination of the cause of the impacts. The different types of SQGs vary in their effectiveness for these applications. Empirical and consensus SQGs provide an estimate of the probability of effects due to chemical contamination level and are thus well suited for overall assessment of impacts. Mechanistic SQGs use partitioning models to determine cause and effect and are thus well suited for applications where determination of cause is needed. The different SQG approaches are complementary in their uses and limitations and both have applications in the assessment and management of contaminated sediment (Di Toro *et. al.* 2005).

The utility and performance of SQGs based on mechanistic, empirical and consensus approaches were evaluated. The approaches included EqP models for nonpolar organics and metals, existing national empirical and consensus guidelines, regional guidelines calibrated to California data, and newly developed guidelines. The evaluation consisted of two phases: preliminary and final. The preliminary evaluation examined a wide range of SQG approaches and assessed the predictive ability (e.g., correlation with respect to sediment toxicity) and feasibility of each approach. Mechanistic SQGs based on EqP models were found to have no significant correlation with California sediment toxicity data in the preliminary analyses and insufficient data (e.g., sediment acid volatile sulfides and simultaneously extracted metals) were available to enable further evaluation of EqP SQGs for metals. These results were consistent with previous analyses using southern California data that showed poor predictive ability of mechanistic SQGs (Vidal and Bay 2005).

The final evaluation of SQG performance examined several empirical and consensus approaches that were identified in the preliminary analyses as best meeting the needs of an SQO assessment framework. The results for the individual chemical components of each SQG were summarized for evaluation as either a mean quotient or maximum probability (Bay *et al*. 2007b, Ritter *et al*. 2007). These summary statistics integrate the effects of the mixture of chemicals present in each sample and have been shown to improve the predictive ability of empirical SQGs (Field *et al*. 2002, Long *et al*. 2006). The SQG approaches evaluated include:

National SQGs

Effects Range Median (National ERM)

The Effects Range Median (ERM; Long *et al*. 1995) represents the concentration above which adverse effects are frequently observed. This value corresponds to the 50th percentile (median value) of the distribution of chemical concentrations associated with adverse biological effects. The subset of National ERM values used in this study was the same as that used in other studies of ERM performance (Long *et al*. 2000). The mean ERM quotient was calculated for a sample by dividing each chemical concentration by its respective ERM and subsequently averaging the individual quotients.

Mean Sediment Quality Guideline Quotient 1 (SQGQ1)
The mean sediment quality guideline quotient 1 (SQGQ1) is based on a set of metal SQGs selected from ERM or PEL and consensus SQGs for PAHs and PCBs (Fairey *et al*. 2001). The suite of chemicals included in the SQGQ1 was selected by Fairey *et al*. to obtain high predictive ability with respect to the incidence of toxicity. The SQGQ1 quotient was calculated for a sample by dividing each chemical concentration by its respective SQG and subsequently averaging the individual quotients.

Consensus Midpoint Effect Concentration (Consensus)
The Consensus SQG approach is based on the integration of different SQG types. Consensus MEC values are the geometric mean of three or more SQGs that correspond to the same biological effect level. This study evaluated Consensus SQG values representing the midpoint effect concentration (MEC), an intermediate level of effect. Consensus values for PAHs and PCBs were obtained from Swartz (1999) and MacDonald et al. (2000), respectively. Values for DDTs, dieldrin, arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc were obtained from Vidal and Bay (2005). The mean Consensus quotient was calculated for a sample by dividing each chemical concentration by its respective SQG and subsequently averaging the individual quotients.

Logistic Regression Model (National LRM)
The Logistic Regression Model (LRM) approach was based on the statistical analysis of paired chemistry and amphipod toxicity data from studies throughout the U.S. (Field et al. 1999, 2002). A logistic regression model is developed for each chemical to estimate the probability of toxicity at a given concentration. LRM models for 18 chemicals having low rates of false positives were selected for use in this study. The LRM method does not establish specific concentration values for each chemical, but rather describes the relationship between contaminant concentrations and the probability of toxicity. The maximum probability of effects obtained from the individual chemical models (P_{max}) was selected to represent the chemical mixture present in a sample (Field et al. 2002).

Regional SQGs
Regional chemical indicators were developed based on two national SQG approaches: ERM and LRM. Three versions of each regional indicator were developed: a statewide version that was calibrated to data from throughout California (CA ERM or CA LRM), and two region-specific versions. The region-specific versions were calibrated separately for northern California (NorCA ERM or NorCA LRM) and southern California (SoCA ERM or SoCA LRM) data sets.

CA ERM, SoCA ERM, NorCA ERM
Individual chemical values analogous to national ERMs were calculated using California data. The data were screened to select toxic samples (>20% mortality) with chemical concentrations >2x median concentration of nontoxic samples. After screening, the data were sorted in ascending order and the median concentration of each chemical was selected as the region-specific ERM value. CA ERM and So CA ERM values were calculated for 27 chemicals, and NorCA ERMs were calculated for 25 chemicals.

CA LRM, SoCA LRM, NorCA LRM
LRM models for individual chemicals were developed for the statewide and regional California data sets. The specific LRM models included in the CA LRM, SoCA LRM, and NorCA LRM approaches were selected from a library of candidate models that included

national models as well as models derived using the California data sets. The selected models were chosen based on the goodness of fit with the observed probability of toxicity.

Mean Chemical Score Indicator (CSI)

The mean CSI is a new SQG developed for the SQO program that is based on the association between chemicals and the magnitude of benthic community disturbance (Ritter *et al*. 2007). Two types of data are combined to calculate the mean CSI: a set of predicted benthic community effects categories based on the individual chemical concentrations and a set of weighting factors reflecting the strength of association between the chemical and benthos response. The chemical values determining the benthic community effect categories were determined for each chemical by a statistical process that identified the chemical ranges producing the best agreement with the biological response categories. Each constituent's predicted effect level is then multiplied by its respective weighting factor to produce a CSI score. Individual CSI scores were combined as a weighted mean to represent chemical mixture effects.

The results of the SQG performance evaluations are described in Bay *et al*. (2007b) and Ritter *et al*. (2007) and summarized in Tables 5.6, 5.7, and 5.8. A regional SQG approach, the CA LRM, had the best ability to predict the toxicity of California sediments. Among the statewide-calibrated SQGs, the CA LRM ranked highest in all three performance measures (correlation, weighted kappa, % agreement). Some of the other statewide-calibrated SQG approaches performed similar to the CA LRM in some respects, but their performance was less consistent (Table 5.6). This study identified regional differences in SQG performance and found that the use of regional data to develop and calibrate SQGs produced a small, but inconsistent, improvement in performance (Table 5.7).

Different correlations with chemistry were obtained for toxicity and benthic condition, suggesting that these two indicators of biological effect are responding differently to contamination or other sediment characteristics. The new benthos-based CSI SQG had greater accuracy for predicting benthic community condition than did SQGs based on toxicity (Table 5.8). The results indicated that the accuracy and ecological relevance of chemical SQGs could be improved by incorporating benthic response data into SQG development.

Table 5.6. Nonparametric Spearman correlation (r) and classification accuracy of statewide SQG approaches for amphipod mortality.

Values in the shaded cells are within the 90th percentile of the highest median value for the bootstrapped analyses. Analyses were conducted on the combined data for the north and south validation data sets and used thresholds calibrated statewide. (Table from Bay *et al*. 2007b)

Region	Approach	Weighted Kappa	% Agreement	r
State	CA LRM	0.23	37	0.35
State	National ERM	0.17	32	0.25
State	Consensus	0.17	31	0.25
State	National LRM	0.15	35	0.22
State	CA ERM	0.17	33	0.20
State	SQGQ1	0.12	32	0.16

Table 5.7. Classification accuracy and Spearman correlation of regional SQG approaches for amphipod mortality.

Values in the shaded cells are within the 90th percentile of the highest median value of the bootstrapped analyses. Analyses were conducted using thresholds for each region separately. (Table from Bay *et al*. 2007b)

	Northern California			Southern California		
Approach	Weighted Kappa	% Agreement	r	Weighted Kappa	% Agreement	r
Regional Calibration						
CA LRM	**0.16**	27	**0.39**	**0.28**	**40**	**0.42**
National ERM	**0.17**	**30**	**0.31**	**0.22**	**38**	0.28
Consensus	**0.15**	**29**	0.23	**0.25**	**39**	**0.31**
National LRM	**0.20**	**33**	0.15	**0.22**	**36**	**0.33**
CA ERM	**0.21**	**33**	0.22	0.13	33	0.18
SQGQ1	**0.21**	**33**	0.25	0.18	33	0.26
Nor/SoCA LRM	**0.21**	**33**	**0.27**	**0.22**	**36**	**0.37**
Nor/SoCA ERM	**0.20**	**35**	**0.22**	0.18	**35**	0.18

Table 5.8. Classification accuracy of CSI and toxicity-based SQG approaches for benthic community condition.

Analyses were conducted using thresholds and data for southern California. (Table from Ritter *et al*. 2007)

Region	Approach	Weighted Kappa	% Agreement
SoCA	CSI	0.44	52
SoCA	CA LRM	0.31	31
SoCA	National ERM	0.26	43

Baseline: Sediment chemistry is typically evaluated by comparison to one or more national empirical SQGs, with little consistency in approach among regions.
Alternate 1: Establish narrative guidance.
Alternate 2: Use existing national empirical SQGs without consideration of actual predictive ability when applied to California data.
Alternate 3: Use either existing, regional, or new empirical SQGs derived from California data. Methodologies and thresholds for applications would be selected based upon how the approach performs within the SQO framework.

Staff Recommendation: Alternative 3.

Proposed Language: See Appendix A, Section V.H. Presented in Appendix C is an example problem and solution based upon the proposed language.

5.4.5 Benthic Community

Benthic communities are found almost universally in aquatic soft sediments and are indicators of choice for monitoring and assessing anthropogenic effects for two main reasons. First, they possess many attributes considered desirable in indicator organisms, including limited mobility, diversity of organism types, life histories that are short enough to reflect recent changes in stressors, and direct exposure to sediment contamination. Second, they are important components of aquatic food webs, transferring carbon and nutrients from suspended particulates in the water column to the sediments by filter feeding and serving as forage for bottom-feeding fishes.

Despite these appealing characteristics, benthic infaunal monitoring data are maximally useful in a regulatory context only when they can be interpreted in relation to scientifically valid criteria or thresholds that distinguish “healthy” from “unhealthy” benthic communities. While reducing complex biological data to index values has disadvantages, the resulting indices remove much of the subjectivity associated with data interpretation. Such indices also provide a simple means of communicating complex information to managers, tracking trends over time, and correlating benthic responses with stressor data (Dauer *et al.* 2000, Hale *et al.* 2004).

During the past decade, several scientifically valid measures of marine and estuarine benthic community condition, often called benthic indices, have been developed for regulatory use. Benthic indices are increasingly accepted by regulators and incorporated into regulatory processes. The U.S. EPA’s guidance for biocriteria development (Gibson *et al.* 2000) recognizes three types of benthic indices, and the agency included benthic assessments in a recent report on nationwide coastal condition to Congress (U.S. EPA 2004). In Maryland and Virginia, the Index of Biotic Integrity is one of the measures used to report on the condition of Chesapeake Bay waters under sections 305(b) and 303(d) of CWA. In California, the Relative Benthic Index (RBI) (Hunt *et al.* 2001) was one of the indicators used by the State Water Board to designate toxic hotspots (SWRCB 2004a) and the Benthic Response Index (BRI)(Smith *et al*. 2001, 2003 and Ranasinghe 2004 was applied by the San Diego Regional Water Board to assess clean-up for three toxic hot-spots in San Diego Bay (Exponent 2002, SCCWRP and Space and Naval Warfare Systems Center San Diego 2004). Due to the presence of benthic communities in good condition as measured by the BRI and other reasons, Santa Monica Bay, which previously was listed as impaired under section 303(d) of the CWA due to sediment concentrations of six metals, was removed from the list in 2003. The BRI has also been used in southern California to assess the extent of bottom area supporting unhealthy benthic communities since 1994 (Bergen *et al.* 1998, Bergen *et al.* 2000, Ranasinghe *et al.* 2003).

5.4.5.1 Choice of metrics used to support the direct effects SQO

There are several impediments to applying benthic indices statewide in California's bays and estuaries. First, several different habitats and benthic assemblages are present in California embayments, each of which requires metric development and calibration. Second, different benthic indices have been used in California at different times and different places, and results cannot be compared across regions because the various indices have not yet been rigorously compared and intercalibrated. Third, initial development of each existing benthic index was constrained by data limitations, and they would all benefit from refinement with additional data as well as independent validation. In addition, there is a lack of knowledge of the effects of differences in: (1) sampling procedures traditional in different regions, (2) habitat factors such as seasonality and sediment type, and (3) accuracy of identification of benthic organisms on performance of California benthic indices. As a result, significant work is required to develop benthic tools for all bays and estuarine habitats.

In order to select the appropriate benthic indices for this program, the technical team compared a number of indexes and combinations of indexes to a California data set validated by nine highly regarded benthic ecologists. This study is described in Ranasinghe *et al.* (2007) and consisted of the following tasks:

- Data for sampling sites in each of the two habitats were identified, acquired, and adjusted to create consistency across sampling programs.
- Five benthic indices were calibrated using a common set of data for all indices.
- Threshold values were selected for each index to assess benthic condition on a four-category scale.
- Performance of the indices and all possible combinations was evaluated by applying the calibrated indices to independent data and comparing the index condition assessments with benthic condition assessments of nine benthic experts.

The benthic indices evaluated in the study include:
Benthic Response Index (BRI), which was originally developed for the southern California mainland shelf and extended into California's bays and estuaries (Smith *et al.* 2001, 2003). The BRI is the abundance-weighted average pollution tolerance score of organisms occurring in a sample.

Index of Benthic Biotic Integrity (IBI), which was developed for freshwater streams and adapted for California's bays and estuaries (Thompson and Lowe 2004). The IBI identifies community measures that have values outside a reference range.

Relative Benthic Index (RBI), which was originally developed for California's Bay Protection and Toxic Cleanup Program (Hunt *et al.* 2001). The RBI is the weighted sum of: (a) several community metrics, (b) the abundances of three positive indicator species, and (c) the presence of two negative indicator species.

River Invertebrate Prediction and Classification System (RIVPACS), which was originally developed for British freshwater streams (Wright *et al.* 1993, Van Sickle *et al.* 2006) and adapted for California's bays and estuaries. The RIVPACS index calculates the number of reference taxa present in the test sample and compares it to the number expected to be present in a reference sample from the same habitat.

Benthic Quality Index (BQI)

The BQI was originally developed for the west coast of Sweden by Rosenberg *et al.* (2004) and applied in the United States for the first time in this project. The BQI is the product of the logarithm ($base_{10}$) of the total number of species and the abundance-weighted average tolerance of organisms occurring in a sample. Species tolerance scores are calculated differently than for the BRI; instead, they are based on relationships of the abundance distributions to Hurlbert's (1971) expected number of species.

Summary of Findings

Index performance was evaluated by comparing index assessments of 34 sites to the best professional judgment of nine benthic experts (Table 5.9). None of the individual indices performed as well as the average expert in ranking sample condition or evaluating whether benthic assemblages exhibited evidence of disturbance. However, several index combinations outperformed the average expert. When results from both habitats were combined, two four-index combinations and a three-index combination performed best.

Table 5.9. Classification accuracy and bias for indices and index combinations.

Classification accuracy is presented for "undisturbed" vs. "disturbed" status and four condition categories. Each of 34 evaluation samples was assessed into one of four numeric categories by the index or index combination and compared with consensus categories from an independent assessment by nine benthic experts. Bias is the sum of differences between index combination and consensus categories; positive values indicate a tendency to score samples as more disturbed than the expert consensus, while negative values indicate a tendency to score samples as less disturbed. The categories were 1: Reference; 2: Marginal; 3: Affected; 4: Severely Affected. Categories 1 and 2 were considered "undisturbed" and 3 and 4 as "disturbed." Index results were combined as the median of the numeric categories; if the median fell between categories, it was rounded to the higher effect category. Means, minima and maxima for concordance between individual experts and the expert consensus are presented below to provide context for the index results. (Table from Ranasinghe et al. 2007a)

			Southern California bays (n=24)			Polyhaline San Francisco Bay (n=10)		
No. of indices	#	Measure	Category Accuracy (%)	Category Bias	Status Accuracy (%)	Category Accuracy (%)	Category Bias	Status Accuracy (%)
One	1	BQI	62.5	8	79.2	90.0	-1	100.0
	2	BRI	58.3	-3	87.5	70.0	-1	100.0
	3	IBI	50.0	-8	70.8	75.0	-1	100.0
	4	RBI	50.0	10	70.8	70.0	3	100.0
	5	RIV	66.7	3	87.5	80.0	0	100.0
Two	6	BQI, BRI	54.2	7	79.2	90.0	1	100.0
	7	BQI, IBI	58.3	6	79.2	90.0	-1	100.0
	8	BQI, RBI	45.8	13	75.0	70.0	3	100.0
	9	BQI, RIV	62.5	11	75.0	80.0	0	100.0
	10	BRI, IBI	66.7	0	83.3	70.0	-1	100.0
	11	BRI, RBI	58.3	9	83.3	70.0	3	100.0
	12	BRI, RIV	62.5	6	83.3	90.0	1	100.0
	13	IBI, RBI	45.8	8	70.8	70.0	3	100.0
	14	IBI, RIV	66.7	3	87.5	80.0	0	100.0
	15	RBI, RIV	45.8	13	75.0	70.0	3	100.0
Three	16	BRI IBI RBI	70.8	-1	87.5	80.0	2	100.0
	17	BQI BRI IBI	66.7	0	87.5	80.0	0	100.0
	18	BQI BRI RBI	70.8	5	83.3	90.0	1	100.0
	19	BQI BRI RIV	70.8	3	91.7	80.0	0	100.0
	20	BQI IBI RBI	66.7	6	83.3	70.0	1	100.0
	21	BQI IBI RIV	75.0	2	91.7	80.0	0	100.0
	22	BQI RBI RIV	66.7	6	83.3	80.0	0	100.0
	23	BRI IBI RIV	62.5	-3	87.5	80.0	0	100.0
	24	BRI RBI RIV	75.0	2	91.7	90.0	1	100.0
	25	IBI RBI RIV	75.0	2	91.7	70.0	1	100.0
Four	26	BRI IBI RBI RIV	75.0	4	91.7	90.0	1	100.0
	27	BQI IBI RBI RIV	66.7	6	83.3	80.0	0	100.0
	28	BQI BRI RBI RIV	70.8	7	83.3	90.0	1	100.0
	29	BQI BRI IBI RIV	79.2	5	91.7	80.0	0	100.0
	30	BQI BRI IBI RBI	70.8	7	83.3	90.0	1	100.0
Five	31	All	75.0	4	91.7	80.0	0	100.0
Individual Experts vs Consensus		Minimum	62.5	+1, -1	83.3	60.0	0	90.0
		Average	80.1	-0.2	91.2	84.4	0.56	94.4
		Maximum	87.5	+4, -3	100.0	100.0	+4, -2	100.0

Baseline: No methods have been approved or adopted by the Water Boards for the habitats under consideration. However, several tools have been applied by the Water Boards for the purposes of hot spot identification, water body assessment and site assessments. Those tools used most frequently in California are the BRI applied currently to embayments and nearshore waters south of Point Conception, (Ranasinghe et al 2007a, 2007b), RBI used within the Bay Protection Program (Hunt et al 1998, Hunt et al 2001, Fairey et al 1996) and IBI used in pilot studies in the San Francisco Bay Regional Monitoring Program (Davis, et al 2006).
Alternative 1: Do not specify the methods.
Alternative 2: Select a single benthic index for all applicable water bodies.
Alternative 3: Select a combination of benthic indices for applicable water bodies.

Staff Recommendation: Alternative 3.

Proposed Language: See Appendix A Section .V.G. Presented in Appendix C is an example problem and solution based upon the proposed language.

5.4.6 Integration of Direct Effects LOE within embayments

Sediment quality is frequently assessed using a triad of chemical concentration, sediment toxicity, and benthic infaunal community condition (Long and Chapman 1985). These are used in combination because sediments are a complex matrix and chemical concentration data alone fails to differentiate between the fraction that is tightly bound to sediment and that which is biologically available. Multiple approaches for integrating these multiple lines of evidence (MLOE) data have been developed (Chapman *et al.* 2002). These integration approaches mostly rely on a similar suite of indicators for each LOE, but differ in how the LOEs are combined into a single assessment. Some are based on combinations of binary responses for each LOE, while others use a more complex statistical summarization. Additionally, some approaches weight the three LOEs equally, while others place differing weight among them. Even within an integration framework, thresholds need to be determined for each LOE. Consensus thresholds for these LOEs don’t yet exist and these threshold decisions are particularly important when the integration is based on a binary decision for each LOE.

At present, no single, universally accepted method for interpreting triad data and classification of sediments based on an MLOE approach exists (Chapman *et al*. 2002; Wenning *et al*. 2005). Each regulatory or monitoring program uses an approach developed through their unique experience. As a result, most triad applications rely on some degree of best professional judgment (BPJ) (Burton *et al*. 2002, Chapman and Anderson 2005). Despite the many decisions inherent in integration of LOEs, BPJ has been found to be reasonably repeatable for interpretation of triad data (Bay *et al*. 2007c). Thus, BPJ can be an acceptable means of integration for site-specific assessments, but it is not easily applicable to large-scale assessments where many sites are involved. As discussed in Section 2, these approaches are rarely if ever applied within the context of a water quality control program.

Within a large and densely populated state like California, the utility of BPJ is limited for many reasons. Its use:

- May result in inconsistent decisions within a single region and from region to region.
- Can be time consuming and resource intensive.
- May not always lead to transparent and unbiased decisions.
- May not allow Regional Water Board staff, permittees, or interested parties to assess the outcome independently.

Logic systems are frequently used to integrate MLOE data; the sediment quality triad was one of the first examples of the use of a logic system to evaluate sediment quality data. Tabular decision matrices that provide an interpretation of various MLOE scenarios are used to apply a logic system. These logic systems are based on a transparent set of criteria used to infer the likelihood of causality for contaminant-related impacts and the system can accommodate various types of scoring systems within each LOE. The rules applied in a logic system can also be modified to reflect specific policy objectives or scientific assumptions, such as giving greater weight to benthic community disturbance relative to toxicity.

The State Water Board's technical team developed a logic-based framework for integrating MLOE to make a station level determination of the likelihood of biological effects due to sediment contamination (Bay and Weisberg 2007). This system was developed in consultation with a stakeholder advisory committee and an independent scientific steering committee. The framework for integrating the three lines of evidence (LOE) to create a station assessment involves a three-step process (~~Plate~~ Figure 5.2). First, the response for each LOE is assigned into one of four response categories: 1) no difference from background conditions, 2) a small response that might not be statistically distinguishable from background conditions, 3) a response that is clearly distinguishable from background, and 4) a large response indicative of extreme conditions.

Second, the individual LOEs are combined to address two key elements of a risk assessment paradigm: 1) Is there biological degradation at the site and 2) Is chemical exposure at the site high enough to potentially result in a biological response? To answer the first question, the benthos and toxicity LOE are integrated to assess the severity of effect (Table 5.10). Benthos is given greater weight in this assessment, as it is the ultimate endpoint of interest (Chapman 2007). The second question arises because the biological response may be attributable to factors other than chemical contaminants. The potential that effects are chemically mediated is assessed using the sediment chemistry and toxicity LOEs (Table 5.11). Chemistry is the more direct measure, but toxicity is also included in this step because of the potential that unmeasured chemicals are present and because of uncertainties in thresholds used to interpret chemical data (Ingersoll *et al*. 2005).

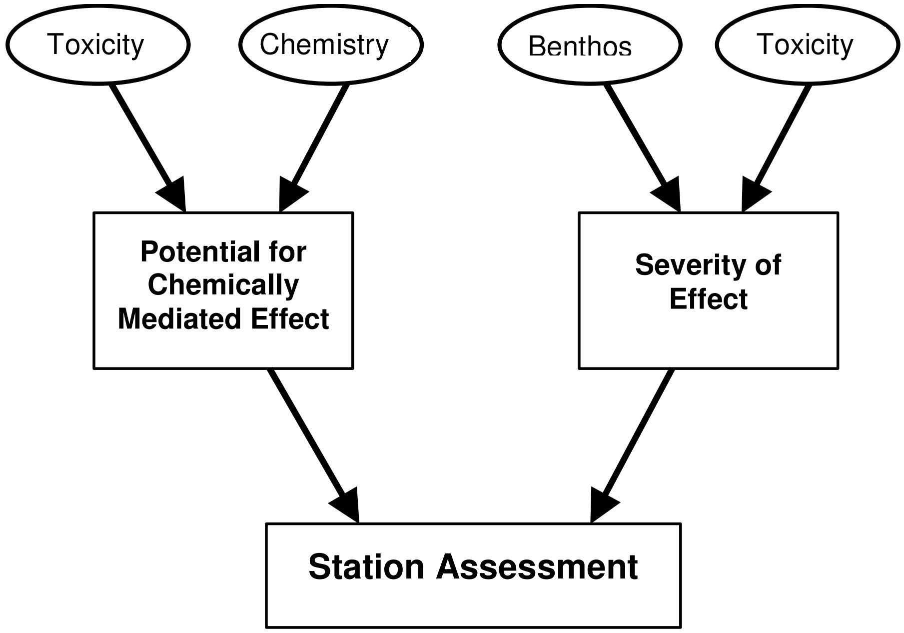


Figure 5.2. Schematic of multiple lines of evidence (MLOE) integration framework.

Table 5.10 Severity of effect classifications, derived from benthos and toxicity LOE.

		Toxicity			
		Nontoxic	Low toxicity	Moderate toxicity	High toxicity
Benthos	Reference	Unaffected	Unaffected	Unaffected	Low effect
	Low disturbance	Unaffected	Low effect	Low effect	Low effect
	Moderate disturbance	Moderate effect	Moderate effect	Moderate effect	Moderate effect
	High disturbance	Moderate effect	High Effect	High Effect	High Effect

Table 5.11. Potential that effects are chemically-mediated categories, derived from chemistry and toxicity LOE.

		Toxicity			
		Nontoxic	Low toxicity	Moderate toxicity	High toxicity
Chemistry	Minimal exposure	Minimal potential	Minimal potential	Low potential	Moderate potential
	Low exposure	Minimal potential	Low potential	Moderate potential	Moderate potential
	Moderate exposure	Low potential	Moderate potential	Moderate potential	Moderate potential
	High exposure	Moderate potential	Moderate potential	High potential	High potential

The final data integration step combines the severity of effect and potential for chemically mediated effects to assign a site into one of six impact categories:

- **Unimpacted.** Confident that sediment contamination is not causing significant adverse impacts to aquatic life living in the sediment at the site.
- **Likely Unimpacted**. Sediment contamination at the site is not expected to cause adverse impacts to aquatic life, but some disagreement among the LOE reduces certainty in classifying the site as unimpacted.
- **Possibly Impacted.** Sediment contamination at the site may be causing adverse impacts to aquatic life, but these impacts are either small or uncertain because of disagreement among LOE.
- **Likely Impacted.** Evidence for a contaminant-related impact to aquatic life at the site is persuasive, even if there is some disagreement among LOE.
- **Clearly Impacted.** Sediment contamination at the site is causing clear and severe adverse impacts to aquatic life.
- **Inconclusive.** Disagreement among the LOE suggests that either the data are suspect or that additional information is needed before a classification can be made.

The decision process for determining the station assessment category is based on a foundation that there must be some evidence of biological effect in order to classify a station as impacted (Table 5.12). Additionally, there must be some evidence of elevated chemical exposure in order to classify a station as chemically impacted.

Table 5.12 Multiple lines of evidence station classifications.

		Severity of Effect			
		Unaffected	Low effect	Moderate effect	High effect
Potential that effects are chemically-mediated	Minimal potential	Unimpacted	Likely unimpacted	Likely unimpacted	Inconclusive
	Low potential	Unimpacted	Likely unimpacted	Possibly impacted	Possibly impacted
	Moderate potential	Likely unimpacted	Possibly impacted or Inconclusive*	Likely impacted	Likely impacted
	High potential	Inconclusive	Likely impacted	Clearly impacted	Clearly impacted

* Inconclusive category when chemistry = minimal exposure, benthos = reference, and toxicity= high.

The efficacy of the framework was assessed by applying it to data from 25 sites and comparing the site classifications to that of six experts that were provided the same data. The framework produced an answer that better matched the median classification of the experts than did five of the six experts (Table 5.13). Moreover, there was little bias in response, as the errors were relatively evenly divided between sites classified as more impacted or less impacted than the median expert classification. The framework was also applied and found to distinguish well sites from known degraded and reference areas within California.

Table 5.13. Summary of categorical assessments for each expert.

Differences in the number of sites are due to the exclusion of sites classified as inconclusive. Disagreement values represent ~~is~~ the total number of category differences between the expert's assessment and the median of all other experts' assessments. Bias values reflect the net of positive or negative assessment differences, with positive numbers indicating a bias toward rating the site as more impacted.

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Framework
# Sites	25	22	25	19	25	22	25
Disagreement	6	16	13	10	14	5	6
Bias	4	-14	12	7	-14	-1	2

Baseline: MLOE is integrated based upon BPJ on a case-by-case basis.
Alternative 1: Support an approach based upon BPJ. As described above, using BPJ does provide some consistency when highly experienced sediment quality scientists are making the assessment, however discrepancies still occur.

Water Board staff do not currently have the same level of expertise. A lack of qualified staff would limit the ability to implement this alternative

Alternative 2: Select an integration method that is based upon a transparent logic-based framework that has been evaluated for accuracy relative to experts and is supported by independent scientific peer review.

Staff Recommendation: Alternative 2.

Proposed Language: See Appendix A, Section VII. I. Presented in Appendix C is an example problem and solution based upon the proposed language.

5.5 INDICATORS APPLICABLE IN ESTUARINE HABITATS

5.5.1 Potential interim tools and methods for the Delta and other estuaries

The State Water Board initiated development of SQOs in 2003 in order to comply with Water Code section 13393 and a court-ordered compliance schedule (See Section 1.2). The schedule required the State Water Board to circulate draft objectives and an implementation policy by August 2006 and to approve and submit the package to the Office of Administrative Law by February 2008.

Section 13393 requires the State Water Board to develop SQOs for bays and estuaries of California. As described in Section 2.2, the State Water Board's Phase I effort focused on those water bodies where chemical and biological data were available to develop indicators and tools to assess sediment quality. Only within southern California bays and most of San Francisco Bay were enough data available to evaluate exposure and effects relationships. Most estuaries including the Sacramento-San Joaquin Delta have not been monitored routinely to assess the impact of toxic pollutants to sediment dwelling organisms; therefore, very little combined effects and exposure data exist within these water bodies. Where data is available, it often consists of only one to three data points. Clearly, the robust data sets required to assess the relationship between exposure and biological effects to benthic communities are far too sparse for the development of assessment tools.

Generally, the type of data required would consist of sediment chemistry-sediment toxicity and benthic community data that encompasses the range of pollutant impacts expected within these water bodies. With such a data set, effects measures such as toxicity and community degradation can be assessed relative to pollutant loading and other disturbances. This is the general approach that has been applied to develop SQOs within California's embayments and is supported by the SQO Scientific Steering Committee. Although the State Water Board recognizes the need to collect additional data and provide funding to achieve this goal, the technical team will not have the data necessary to complete the appropriate analyses until 2008. As a result, there is a need to consider other interim options in order to comply with the court's decision.

Single LOE Chemistry or Toxicity

The State Water Board could propose the use of Sediment Chemistry Guidelines (SQGs) such as the ERMs (See Section 5.5.3.2) or apparent effects thresholds as a single LOE indicator of sediment quality in estuaries. SQGs are existing chemical thresholds that have been applied to assist managers when making decisions about sediment quality. Some of these approaches were developed in part from estuarine data. This approach would require little or no resources to prepare as existing sediment thresholds could be proposed and could be applied to determine whether sediment exceeds the narrative objective. As stated previously, there are significant problems when this LOE is used without the benefit of the other LOE.

Sediment toxicity could be proposed as a stand-alone tool for the assessment of sediment quality. There are two species within the proposed embayments suite of toxicity test methods that tolerate the salinity range of some estuarine waters. However, additional test methods need to be selected and calibrated in order to apply the recommended combination of acute and sublethal toxicity tests at most sites. As described above, this approach could be applied to determine whether sediment exceeds the narrative objective described in Section 2.11, or a toxicity-specific narrative objective could be proposed. Sediment toxicity has been applied within many different water bodies; however, similar limitations persist with this tool as well. The use of toxicity tests without other LOE would increate the likelihood of underestimating sediment that is due to seasonal events or contaminants that require chronic exposure to produce an adverse effect. Confounding factors and uncertainty also limit the ability to use this single LOE to assess sediment quality.

Combination of Sediment Chemistry and Toxicity

Sediment chemistry and toxicity could be integrated into a two-line of evidence approach. This approach would provide greater confidence in the assessment compared to a single LOE approach. However, the selection of appropriate thresholds would be difficult. Thresholds could be adopted from those proposed for sediment chemistry and toxicity in embayments. However, there may be little or no correlation between organism response in embayments and that in estuaries. The toxicity and chemistry lines of evidence could be interpreted relative to site-specific reference sites, providing only two possible outcomes for each LOE: good or bad. However, determination of reference sites is often contentious and typically requires a large amount of data to support the hypothesis. This approach gives more flexibility and responsibility to local agencies, and may be inconsistently applied.

The State Water Board would need to establish some thresholds to implement the two LOE approach in order to reduce the use of BPJ, which does not promote statewide consistency and promotes adversarial science. While it may not be possible to develop multiple thresholds that provide the same level of discrimination as those being developed for embayments, the State Water Board could provide thresholds that would enable a manager to respond quickly to relatively high level of effects.
This approach would be developed based on the following considerations.

- Develop an integration approach that accounts for greater uncertainty associated with application in estuaries.
- Utilize fewer categories of effect or exposure to reflect present lack of knowledge.
- May require a greater number of inconclusive categories for situations where LOE are not in agreement, additional data collection (e.g., benthos) or analysis is needed before an assessment can be made. Current embayment chemical indicators and thresholds have not been validated for use in estuaries, and as a result may not be accurate or effective.
- Additional toxicity test methods that are compatible with freshwater (e.g., *Hyallella azteca* survival test and *Chironomus dilutus* growth test) may be needed, depending on salinities at time of collection.

Three LOE: Chemistry, Toxicity and Benthic Community
A more rigorous approach would be to use the sediment quality triad as it has been applied traditionally in areas where little prior sediment quality information was available. In this case, two independent data sets of chemistry, sediment toxicity and benthic community measures are required. The first data set would define the baseline conditions or reference envelope for the area of interest. A second data set would contain the sediment quality measures in the area of interest. Data from each line of evidence would be compared to the baseline data if adequate thresholds for data interpretation were not available. Statistically significant differences relative to the reference envelope among two of the three lines of evidence would trigger an impacted designation for the study site. This approach is consistent with the overall conceptual approach and underlying philosophy of the embayments approach and has been applied throughout the country.

Table 5.14. Potential measures for LOE evaluation in estuaries.

LOE	*MEASURES*	*COMPARISON VALUE*
Chemistry	*Existing analyte list plus other chemicals of concern*	*Reference envelope or SQGs*
Sediment Toxicity	*Survival* - Hyalella azteca *Growth* – Chironomus dilutus	*Reference envelope or numeric threshold from similar programs*
Benthic Community	*Benthic macrofauna identification and abundance*	*Reference envelope*

The sediment quality triad is commonly applied to assess sediment quality in habitats when little is known about the biological and toxicological characteristics of the study area. This approach requires an even greater use of BPJ compared to the two LOE approach. BPJ would be required to decide which measures to use, what thresholds or reference envelope to compare the results against, and how to integrate the LOE. The need to collect additional data in order to establish a reference envelope may also increase the cost and complexity of monitoring programs.

Baseline: Not applicable.
Alternative 1: Do not propose any tools for implementing the narrative SQOs until data is collected in Phase II, and the technical team has the time to develop appropriate tools.
Alternative 2: Propose the use of a single LOE for delta waters.
Alternative 3: Propose using sediment toxicity and chemistry to implement the narrative objective. The Scientific Steering Committee was critical of this approach.
Alternative 4: Propose using the sediment quality triad (chemistry, toxicity, benthic community condition) to implement the narrative objective. Additional development and evaluation will be required before a detailed approach is proposed.

Staff Recommendation: Alternative 4.

Proposed Language: See Appendix A, Section .V.J.

5.5.2 Sunset date for interim tools

Some stakeholders have expressed concern that the State Water Board could adopt interim tools for the Delta and other estuaries without providing any guarantee that these tools will not be replaced by more fully developed implementation measures scheduled for development under Phase II. Although the State Water Board provided additional funding to develop Phase II tools, there is always some uncertainty associated with future planning efforts.

Baseline: Not applicable.
Alternative 1: Do not provide sunsetting language in the draft Part 1 for the water bodies with less robust tools.
Alternative 2: Provide language that sunsets interim implementation tools if the State Water Board has not developed more robust tools by a specific date.
Alternative 3: Provide language in the resolution adopting Phase I that the State Board will revisit the interim implementation tools in Phase II

Staff Recommendation: Alternative 3.

5.6 PROTECTIVE CONDITION

While proposing six categories to describe the condition of sediments provides for greater understanding of the sediment quality in a water body, the proposed Part 1 must define what categories are considered protective or degraded in order to fit the binary (pass/fail) model applied within all current regulatory programs. Section 13391.5(d) of Porter Cologne provides some guidance stating that the SQOs must be established with an adequate margin of safety for the reasonable protection of the beneficial uses of water. Defining what is protective versus what is considered the unprotective or degraded condition must meet this requirement.
As described previously, the six categories are:

- **Unimpacted.** Confident that sediment contamination is not causing significant adverse impacts to aquatic life living in the sediment at the site.
- **Likely Unimpacted**. Sediment contamination at the site is not expected to cause adverse impacts to aquatic life, but some disagreement among the LOE reduces certainty in classifying the site as unimpacted.
- **Possibly Impacted.** Sediment contamination at the site may be causing adverse impacts to aquatic life, but these impacts are either small or uncertain because of disagreement among LOE.
- **Likely Impacted.** Evidence for a contaminant-related impact to aquatic life at the site is persuasive, even if there is some disagreement among LOE.
- **Clearly Impacted.** Sediment contamination at the site is causing clear and severe adverse impacts to aquatic life.
- **Inconclusive.** Disagreement among the LOE suggests that either the data are suspect or that additional information is needed before a classification can be made.

Most would agree that from the definitions, *Unimpacted* would describe a protected condition while "*Clearly Impacted"* would represent a highly degraded condition. These two cases are the easiest to classify confidently as a result of strong concordance amongst all three LOE. The next two cases; "*Likely Unimpacted"* and *"Likely Impacted"* represent the protective and degraded condition albeit with a lower level of confidence as a result of some disagreement among the LOE, however within these categories, two of the LOE are compelling. The middle category designated "*Possibly Impacted"* represents the greatest uncertainty and disagreement amongst the LOE of the categories. Stations within this category may be either unimpacted or impacted.

There are five possible options that could be applied to provide a binary determination: Three of these options are considered below.

1. Protected sediments could be defined as those sediments within the "*Unimpacted"* Category only. All other categories would be considered as not representing the protective condition. This would represent a very conservative approach but does provide for an adequate margin of safety.

2. Protected sediments could be defined by the categories "*Unimpacted"* and "*Likely Unimpacted"*. All other categories would be considered as not representing the protective condition. This option also provides for a margin of safety as the next category "*Possibly Impacted"* indicates that there would be more sites in this category that are unimpacted then actually impacted.

3. Protected sediments could be defined by the categories *Unimpacted, Likely Unimpacted and Possibly Impacted*. All other categories would be considered as not representing the protective condition. While the *Possibly Impacted* category only suggests the possibility of the station being impacted, there is lower confidence that sediment quality at this site is protective relative to the proposed narrative objective.

   Baseline: MLOE assessments applied sediment quality are typically decided by best professional judgment.
   Alternative 1: Protected sediments could be defined as those sediments within the "*Unimpacted"* Category only.
   Alternative 2: Protected sediments could be defined by the categories "*Unimpacted"* and "*Likely Unimpacted"*.
   Alternative 3: Protected sediments could be defined by the categories *Unimpacted, Likely Unimpacted and Possibly Impacted*

Staff Recommendation: Alternative 2.

Proposed Language: See Appendix A Section .V.I and J.

5.7. APPLICATION OF PROPOSED WITHIN SPECIFIC PROGRAMS

As explained in Section 4, the Basin Plans for all of the coastal Regional Water Boards contain water quality standards, including narrative water quality objectives, that apply to sediment quality in bays and estuaries. Under existing law, these standards are implemented through several regulatory programs. The standards are implemented in

NPDES permits regulating the point source discharges and in waste discharge requirements, conditional waivers or prohibitions for nonpoint source discharges to bay and estuarine waters. The standards also provide the basis for enforcement actions, including cleanup and abatement activities, and for water quality certifications under Clean Water Act section 401. Bay and estuarine waters that do not meet the standards must be listed under Clean Water Act section 303(d), and appropriate TMDLs must be developed to attain the standards.

The proposed SQOs will add an objective that specifically addresses sediment quality in the coastal regions. The narrative SQOs and implementation tools were developed to assess whether pollutants in sediments pose a risk or are causing or contributing to the degradation of ecologically important and sensitive sediment dwelling organisms directly exposed to the pollutants in sediment. As a result, the SQO and tools will provide a robust measure of ambient sediment quality that directly relates to beneficial use protection.

The proposed SQOs will be implemented under the existing regulatory programs described in Section 4. This Section describes how the proposed SQOs could be implemented within these programs.

5.7.1 Applicability to Sediment Cleanup Actions

Draft Part 1 could be applied to support site cleanup actions if the receptors addressed in draft Part 1 are consistent with those at risk. . Receptors that may be exposed include benthic invertebrates, fish, birds, marine mammals and humans through consumption of fish tissue. As a result human health and ecological risk assessments are used to both assess risk and assist in the derivation of receptor specific cleanup goals. The SQOs and supporting tools could be applied to determine what sediments within a specific area are protected or degraded for benthic communities. Stressor identification and development of site-specific management guidelines could also be applied to address potential cleanup actions focused on benthic communities.

As discussed in Section 4.2.2, Resolution *No. 92-49, "Policies and Procedures for Investigation and Cleanup and Abatement of Discharges Under Water Code Section 13304,* could be incorporated into the draft Part 1 which encompasses both the investigation and development of cleanup goals. Under 92-49, cleanup levels range from background to the best water quality that is reasonable, but not to exceed applicable water quality standards. Development of biology based site-specific sediment management guidelines would assist Regional Boards in complying with this policy.

Baseline: Regional Water Boards require human health and/or ecological risk assessments to assess the exposure to all receptors. The relative risks posed to each receptor are calculated to determine which receptors are most sensitive to the pollutants of concern.
Alternative 1: Apply 92-49 to cleanups of sites not meeting the SQOs. Under 92-49, cleanup levels range from background to the best water quality that is reasonable, but not to exceed applicable water quality standards. Stressor identification and development of site-specific sediment management guidelines could support this effort.
Alternative 2: Prepare language describing how and when the SQOs could be applied to cleanup actions. This policy could be applied to assist in characterizing risk at cleanup action sites when the receptors of interest, the

exposure type, and scale of effort are identical or similar to those protected by this policy. The exposure receptor scenarios not protected by this policy would need to be evaluated using ecological and human health risk assessment guidance such as that prepared by the Department of Toxic Substances Control (DTSC), the Office of Environmental Health Hazard Assessment (OEHHA), and U.S. EPA.

Staff Recommendation: Alternative 1.

Proposed Language: See Appendix A, Section VII.G.

5.7.2 Applicability to dredged materials management

Water Code section 13396 states that the State and Regional Water Boards shall not grant approval for a dredging project that involves the removal or disturbance of sediment that contains pollutants at or above the (SQOs) established pursuant to Section 13393 unless the Water Boards determine all of the following:

(a): the polluted sediment will be removed in a manner that prevents or minimizes water quality degradation.
(b): polluted dredge spoils will not be deposited in a location that may cause significant adverse effects to aquatic life, fish, shellfish, or wildlife or may harm the beneficial uses of the receiving waters, or does not create maximum benefit to the people of the State.
(c): the project or activity will not cause significant adverse impacts upon a federal sanctuary, recreational area, or other waters of significant national importance.

California SQOs for enclosed bays and estuaries are being developed to protect sensitive aquatic organisms and other beneficial uses from the adverse effects of exposure to pollutants present in in-place surficial sediments. Section 13396 makes it clear that SQOs apply to dredged material. However, Section 13396 also allows dredged material that exceeds SQOs to be approved for discharge into waters of the State of California when conditions (a)-(c) are met. One difficulty is that some of the procedures used by California to determine the SQOs are not technically applicable to sediments below the biologically active layer (e.g., benthic community analysis). Dredged material, however, is typically composed *primarily* of sediments from below the biologically active layer. In addition, some of the test species used to determine the California SQOs are not necessarily appropriate to use for dredged material testing in all cases. The federal evaluation procedures discussed below were specifically developed to characterize the full spectrum of dredged material (not just surface sediments) in order to determine suitability for aquatic discharge in a variety of disposal or placement scenarios. Furthermore, the federal procedures emphasize conducting these dredged material evaluations in a nationally consistent manner.

Under the authority of the CWA and the Marine Protection, Research, and Sanctuaries Act (MPRSA), and their implementing regulations, the USACE and U.S. EPA jointly developed national testing guidance manuals for dredged material (the Inland Testing Manual or ITM for non-ocean waters, USACE and U.S. EPA 1998; and the Ocean Testing Manual or OTM for ocean waters, USACE and U.S. EPA 1991). These manuals utilize a tiered, effects-based evaluation scheme to determine the suitability of dredged material for aquatic placement or disposal. Each of these national sediment-testing manuals is implemented under a national Technical Framework for Dredged Material Management ("Framework") also jointly published by the USACE and U.S. EPA. (1992). The purpose of the Framework is to facilitate consistency in how the sediment evaluation procedures are applied within and between various areas of the United States. In addition, the Framework describes the broader regulatory context within which sediment evaluations conducted under the ITM or OTM are carried out so as to meet the overall goals of the CWA and MPRSA. In particular, under the Framework, suitability determinations for aquatic discharge of dredged material take into account not only the technical sediment test results from the ITM or OTM, but also the characteristics of the individual disposal sites and the practicability of alternatives to aquatic disposal (including beneficial reuse alternatives).

Certain other federal programs that otherwise address contaminated sediments generally defer to this Framework when it comes to management of dredged material. For example, in U.S. EPA Region 9, U.S. EPA regularly allows navigation dredging to continue within the boundaries of sediment remediation study areas for projects in the Remedial Investigation/Feasibility Study (RI/FS) stage under the Comprehensive Environmental Recovery, Cleanup, and Liability Act (CERCLA), provided that the dredged material is first specifically evaluated under the Framework, and its discharge is managed under a CWA Section 404 or MPRSA Section 103 permit. Similarly, at the national level, U.S. EPA excluded dredged material from the definition of hazardous waste under Subtitle C of the Resource Conservation and Recovery Act (RCRA), when it is subject to a CWA Section 404 or MPRSA Section 103 permit. As U.S. EPA noted in the Hazardous Remediation Waste Management Requirements (HWIR-Media) Final Rule (U.S. EPA 1998A):

> "Dredged material that is subject to the requirements of a permit that has been issued under 404 of the Federal Water Pollution Control Act (33 U.S.C.1344) or section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972 (33 U.S.C. 1413) is not a hazardous waste."
>
> "Testing procedures under the CWA and MPRSA … are better suited to the chemical and biological evaluation of dredged material disposed of in the aquatic environment. These tests are specifically designed to evaluate effects such as the potential contaminant-related impacts associated with the discharge of dredged material into oceans and waterways of the United States. The Agency believes that the CWA and MPRSA permit programs protect human health and the environment from the consequences of dredged material disposal to an extent that is at least as protective as the RCRA Subtitle C program. These programs incorporate appropriate biological and chemical assessments to evaluate potential impacts on water column and benthic organisms, and the potential for human health impacts caused by food chain transfer of contaminants. As improved assessment methods are developed, they can be incorporated into these procedures. The programs also make available appropriate control measures (for example, 40 CFR 230.72) for addressing contamination in each of the relevant pathways."

Under the federal Framework (USACE and U.S. EPA, 1992) the ITM and OTM provide for application of relevant chemical sediment quality criteria (SQC) or Sediment Quality Standards (SQS) issued by U.S. EPA or by a state, respectively, as screening step in

“Tier I” or “Tier II” of their evaluation procedures. Exceedance of SQC or SQS indicates the need for direct effects-based testing at a higher tier. Any numeric chemical SQOs that California promulgates could be applied in this manner. Section 13396 provides that even when California SQOs are exceeded, dredging and discharge may still be allowed when conditions (a)-(c) are met. As described below, the higher-tier evaluation procedures of the ITM or OTM, and other considerations of the CWA and MPRSA as described in the Framework, provide an appropriate and consistent basis for the State to determine whether conditions (a)-(c) have in fact been met.

> <u>Condition (a)</u> requires that the polluted sediment will be removed in a manner that prevents or minimizes water quality degradation. This condition focuses on the dredging (or removal) site itself, as opposed to the dredged material disposal site. It is addressed by any Best Management Practices (BMPs) or special conditions, incorporated in the dredging permit(s) or other authorizations, that federal or State agencies (including the State and Regional Water Boards) determine to be necessary for the protection of water quality and beneficial uses. These may include monitoring; constraints on dredging equipment type; operation; and timing, control technologies such as silt curtains, etc. The federal evaluation Framework generates specific information relevant to making determinations about the need for any controls at the dredging site, via physical-chemical characterization and via the water column (suspended-liquid phase) bioassays conducted on dredged material samples.
>
> <u>Condition (b)</u> focuses on the discharge of dredged material at the disposal or placement site. The evaluation procedures in the ITM and OTM were specifically designed to address each of the relevant pollutant exposure pathways that may be associated with dredged material discharges at aquatic disposal sites. These procedures provide for the comprehensive physical, chemical, and biological evaluation of the specific sediments to be dredged and discharged. Biological testing includes both liquid-suspended phase and solid phase sediment testing using appropriately sensitive indicator organisms that cover a range of functional feeding types. There is flexibility to use appropriate species for different dredged material types and situations. When necessary, information from the bioaccumulation tests can be readily used to assess the environmental risk of food web transfer of pollutants to different trophic levels. The national testing manuals also provide for updating the specific tests used; for example, to include regionally important species or as more sensitive tests (possibly including chronic/sublethal assays) are developed sufficiently for reliable regulatory use nationwide.
>
> Another important consideration is that dredged material that may pose a risk at a particular disposal site or when managed in a particular manner, may not pose such a risk at a different disposal site or if managed in a different manner. The overall federal Framework incorporates CWA and MPRSA provisions that ensure suitable determinations take into account all relevant sediment-specific and disposal site-specific factors, and any management actions necessary to minimize adverse impacts. SQOs as stand-alone factors cannot do this.
>
> <u>Condition (c)</u> is consistent with already existing requirements of the CWA and MPRSA programs. In particular, the USACE generally may not authorize the discharge of dredged (or fill) material into waters of the United States that would

cause the kinds of impacts listed in 40 C.F.R. §230.10, including significant impacts to designated marine sanctuaries, whether such impacts are caused by pollutants associated with the sediments or simply by the physical discharge of the sediments. In addition, the CWA program focuses on identifying and, to the maximum extent possible, avoiding impacts to "aquatic resources of national importance."

Baseline: USACE, under the authority of the federal CWA and MPRSA and in coordination with U.S. EPA, prepared the ITM (USACE and U.S. EPA 1998) and the OTM (USACE and U.S. EPA 1992) to address the suitability of dredged material for disposal. These manuals are not intended to assess in-place sediments; rather, these methodologies were designed to assess potential effects that may occur during or after disposal of the dredged materials. At the regional level, USACE, U.S. EPA, State Water Board staff, and staff from other State agencies have also prepared water body specific guidance and formed dredged materials management teams to streamline the onerous multi-jurisdictional regulatory process (USACE et al, 2001).

Alternative 1: SQOs should be applicable to dredged material. The proposed SQOs could be applied to dredged materials; however, collection of this information would not eliminate the need to perform the suitability tests described in the ITM or the OTM in accordance with the federal CWA or MPRSA.

Alternative 2: SQOs should not be applicable to dredged materials. These SQOs and supporting tools were intended to evaluate beneficial uses protection and, as a result, only focus on the in-place biologically active layer. The Dredged Materials program was designed to measure average bulk properties of sediment to determine both the appropriate method of disposal or reuse and assess potential effects caused by the dredging and disposal action. While some tools are similar, the application and implementation of the tools differs significantly.

Alternative 3: SQOs would only apply under specific conditions specified in section 13396.

Staff Recommendation: Alternative 3.

Proposed Language: *See Appendix A, Section VII.A.*

5.7.3 Applicability to 303(d) Listings

As explained in Section 4.2.1 of this report, the State Water Board's Section 303(d) Listing Policy currently provides that a water segment shall be placed on the list if the segment exhibits statistically significant sediment toxicity based on a binomial distribution. The segment must be listed if the observed sediment toxicity is associated with a pollutant. The segment may also be listed for toxicity alone. The Section 303(d) Listing Policy predates Part 1; consequently, the policy does not specifically address listings based on the proposed SQOs.

A multi-station assessment tool will integrate the results of many single station assessments into a single watershed-based or water body assessment. This tool will help determine whether the water body is consistent with the narrative SQOs. The proposed MLOE approach uses evidence from chemistry, toxicity, and the benthic community structure to make a single station assessment. At each station, sediment quality will be categorized into one of five ordered categories: "unimpacted" "likely unimpacted" "possibly impacted" "likely impacted" "clearly impacted." This type of ordinal data is interpretable in terms of its arrangement in a given order, e.g., from lowest to highest.

Results measured on an ordinal scale, however, may limit the types of appropriate statistical methods that can be applied during a multi-station assessment. Nonparametric methods are usually used with ordinal data, while parametric methods are usually used with interval or ratio data (Stevens 1946). Some researchers, however, have concluded that treating ordinal data as if they were interval data is unlikely to lead to improper conclusions (Gardner 1975). The following is a list of preliminary ideas for statistical tests that could be used to assess multiple station sediment data:

a. Tests of Exceedance. Convert each single station assessment into binary yes-or-no type data value. A water body would then be characterized by a count of the number of exceedances and the number of non-exceedances. A binomial test can then be used to determine if the proportion of exceedances is significantly excessive. This is the approach taken in the State's current 303(d) Listing Policy (SWRCB 2004) for listings based on exceedances of numeric criteria or objectives for toxic pollutants. This approach does not consider the magnitude of the exceedance. For this alternative, it is important to understand that the application of SQOs cannot supercede all sediment listing criteria for several reasons

- There are many waterbodies where SQOs do not apply, such as rivers, lakes, and ocean waters.
- The SQOs were not developed to assess exposure associated with "non" priority pollutants
- The SQOs were not developed to explicitly protect receptors such as fish, birds, marine mammals and the bioaccumulation from sediment up the aquatic food chain

b. Goodness of Fit Tests. The observed frequencies in each assessment category are compared to frequencies expected in each category under a specified null distribution. Sufficiently large deviations from the expected frequencies will support the conclusion that the data did not come from the hypothesized distribution. Chi-squared and Kolmogorov-Smirnov one-sample goodness-of-fit tests are examples. This option does not fully utilize the ordinal scale of the data.

c. Tests of Location. These tests work by subjectively assigning numeric integer values to ordinal data. For example, a value of 1 is assigned to stations classified as "unimpacted," a value of 2 is assigned to stations classified as "likely unimpacted," and so on. A one-sample parametric *t*-test can be used to test for a significant difference between the observed mean and the hypothesized mean. Similarly, a one-sample non-parametric Wilcoxon signed rank test can be used to test for a significant difference between the observed median and the hypothesized median. These tests of location account for magnitude.

Alternative 1: Do not consider the SQOs for listing purposes.
Alternative 2: Utilize an approach that is consistent with the approach for listing waters based on exceedances of numeric criteria or objectives for toxic pollutants, which is described in 303(d) listing policy (SWRCB 2004) and under a. above.
Alternative 3: Evaluate a variety of approaches such as b and c described above for applying SQOs to the listing process.

Staff Recommendation: Alternative 2. Under this alternative, the Water Boards will continue to list water segments for sediment toxicity under the current Section 303(d) Listing Policy, unless the listing is due to exceedance of the aquatic life SQOs in Part 1 in bays or estuaries. In the latter case, listings will follow the approach described in a. above. The State Water Board may reconsider the Section 303(d) Listing Policy, if appropriate, in the future to further address listings for sediment toxicity.

Proposed Language: See Appendix A Section VII.E.8.

5.7.4 Applicability to NPDES Permits

In general, under the Clean Water Act and implementing regulations, water quality objectives are typically translated into effluent limits when the discharge of specific pollutants has the "reasonable potential" to cause or contribute to water quality standards exceedances. In assessing reasonable potential, the permitting authority can consider a variety of factors and information. The State Water Board's SIP contains specific requirements for determining the need for numeric effluent limitations regulating the discharge of priority toxic pollutants. Additional guidance on determining reasonable potential is found in U.S. EPA's Technical Support Document for Water Quality-based Toxics Control (1991).

During the late 1980's, the State Water Board assessed the relationship between sediment deposition, pollutant loading, and effluent quality (Hendricks 1990) in an attempt to develop a process for deriving sediment-based effluent limits. The Washington Department of Ecology developed similar tools to calculate effluent limits based upon chemical concentrations in sediments within Puget Sound (Bailey 2005). Application of these tools to derive effluent limits has been limited for several reasons.

- Chemical concentrations in sediment do not represent the bioavailable fraction.
- Chemical thresholds are not based upon causal association.
- Pollutants discharged undergo chemical processes that vary depending upon the chemistry and physical properties of the effluent and receiving water.
- Sediment fate and transport must be well characterized.

In appropriate cases, water quality objectives can also be implemented in NPDES permits as receiving water limits. Receiving water limits are typically used when the water quality objective cannot be directly translated to effluent limits or when there is a clear need to monitor compliance within the receiving water. Examples include biological narratives and bacteria receiving water limits described in the California Ocean Plan (SWRCB, 2005).

Because it is not feasible at the present time to directly translate the SQOs into numeric effluent limits, the SQOs and implementation tools can be implemented as receiving water limits in NPDES permits. Receiving water limits should be included in permits if sediment quality in the vicinity of a permitted discharge to a bay or estuary is potentially at risk due to toxic pollutants in the discharge. In determining the need for receiving water limits, the Water Boards will have to use BPJ and consider all available and relevant information. This could include the location and characteristics of the discharge and the receiving waters.

Baseline: Not applicable.

Alternative 1: Do not address implementation of SQOs in NPDES permits.
Alternative 2: Develop translator tools that would enable the calculation of effluent limits from chemistry-based sediment thresholds.
Alternative 3: Propose that the narrative SQOs be implemented in NPDES permits as receiving water limits.

Staff Recommendation: Alternative 3.

Proposed Language: See Appendix A, Section VII.B.

5.7.4.1 Defining receiving water limit exceedances

In general, demonstrating an exceedance of a numeric effluent limitation is fairly straightforward. Typically, there is an exceedance if the pollutant concentration in a monitoring sample is greater than the effluent limitation. Determining an exceedance of a receiving water limit implementing the proposed SQOs poses a greater challenge.

The proposed aquatic life SQO addresses pollutants in sediments that, alone or in combination, are toxic to benthic communities. The protected condition defined in Section 5.6 can be applied to individual stations. However integrating data from multiple stations is also necessary to ensure the evaluation of receiving water limits takes into consideration all available data. The protected condition defined in Section 5.6 could be coupled with the binomial statistic used by the Water Boards for 303(d) Listings to assess exceedances of receiving water limits using multiple stations designated in the permit. However coupling the MLOE based protected condition with the binomial statistic does not lead to the identity of a specific toxic pollutant stressor. In order to demonstrate an exceedance of the proposed SQO, a toxic pollutant or pollutants must be identified. Additional studies would be required to identify the specific cause. This effort requires stressor identification studies similar to the Toxicity Identification Evaluation process developed and utilized by U.S. EPA for the Whole Effluent Toxicity (WET) program (U.S. EPA 1999) and the process described in U.S. EPA's aquatic stressor identification guidance document (U.S.EPA 2002).

Performing stressor identification can also be tailored to address the confidence and magnitude of the assessment. For example sites classified as possibly impacted indicate that toxic pollutants may be causing adverse impacts to aquatic life (described in Section 5.6). In this case the exposure and biological effect maybe nominal or transient. In this example the ability to differentiate natural stressors and random variability from pollutant related stress might be difficult. However sites classified as likely or clearly impacted should clearly be prioritized for several reasons. First, the confidence in these assessment categories supports the need for priority response. Second, as the magnitude of the exposure and the biological effects increases, a greater number of tools could be applied to stressor identification, which increases the probability of establishing cause. Finally, resolving some of problems associated with likely and clearly impacted stations may help in resolving some of the problems associated with possibly impacted station clusters in the vicinity.

Baseline: Not applicable.
Alternative 1: Provide no guidance beyond the MLOE based protected condition as described in Section 5.6 to assess exceedances of receiving water limit.
Alternative 2: Provide guidance in the Draft Part 1 that would consist of a multi station assessment followed by stressor identification to determine the cause

based upon the station categories. This language would also describe situations where findings support a conclusion that the narrative objective is met.

Staff Recommendation: Alternative 2

Proposed Language: See Appendix A, Section VII.C**.**

5.7.4.2 Monitoring frequency in NPDES permits

Sediment toxicity studies in southern California bays are indicate that there may be variable rates of temporal changes in sediment quality. Sediment toxicity in some bays has changed little over five years whereas conditions in other bays may change more frequently (Bay et al 2005). In San Francisco, sediment toxicity varies seasonally, yet the year-to-year sediment toxicity appears in many places to be relatively consistent (Anderson et al, 2007). The model monitoring program developed by SCCWRP for the southern California Bight recommends that the sediment monitoring frequency be based on the management objectives of the program, within a range of one to five years (Schiff et al, 2001). In order to monitor the impact of discharges the model-monitoring program suggests that the appropriate frequency be established after time series data has been collected for major dischargers. A frequency-limiting factor is the benthic community. The benthic indices proposed for use were developed using data collected in summer periods and as a result should only be applied during this season. Considering the above information the maximum frequency of once a year and a minimum frequency of once every five years (one permit cycle) would be appropriate.

Baseline: Not applicable.
Alternative 1: Do not specify a monitoring frequency. This alternative does not provide consistency throughout the coastal Regional Water Boards.
Alternative 2: Require permittees to collect time series data to determine appropriate frequency. This alternative may require the collection of a great deal of data before a monitoring frequency can be established.
Alternative 3: Require Phase I Stormwater Discharges and Major Discharges to monitor less frequently than twice per permit cycle. Require Phase II Stormwater and Minor Discharges to monitor more often then twice per permit cycle or less then once per permit cycle.

Staff Recommendation: Alternative 3.

Proposed Language: See Appendix A, Section VII.D.

5.7.4.3 Potential response actions for exceedances

Regulatory decisions or management actions are typically based upon the simple co-occurrence of pollutants that exceed a sediment quality guideline and biological effects measured at the same station or another station within the waterbody segment. Although this relationship does not demonstrate causality, TMDLs for each of these pollutants that exceed a sediment quality guideline are frequently required. As a result enormous resources are applied to develop control strategies for a large number of pollutants instead of focusing on the specific causes. There are also situations where routine chemical analysis does not include the identification of the pollutants that are responsible for the observed biological effects. In such situations, the true stressor is not considered in the development of control strategies. If stressor identification is performed and a stressor is identified, a logical application would be the development of biologically relevant guidelines that could be applied to support TMDL development or remediation goals. Guideline development would account for site and receptor specific factors that control bioavailability. Adopting sediment quality guidelines to fulfill this role does not account for these factors

> **Baseline:** Not applicable.
> **Alternative 1:** Do not provide guidance in the Draft Part 1 to support stressor identification and the development of additional biologically relevant guidelines in support of TMDLs or remediation goals
> **Alternative 2:** Provide guidance in the Draft Part 1 to support stressor identification and the development of additional biologically relevant guidelines in support of TMDLs or remediation goals

Staff Recommendation: Alternative 2.

Proposed Language: See Appendix A, Section 3.VII.F and H.

5.7.4.4 Process diagram for application of the direct effects narrative objective

The Biological monitoring requires Sections 5.8.1 through 5.8.4 describe the potential means by which the direct effects draft narrative SQO and supporting tools could be applied within different water quality protection and control programs. However, members of the Advisory Committee have expressed a desire to include process figures to better communicate the basic approach and to further support consistent implementation and use across regions. The process figures would describe relevant response actions when an exceedance occurs and also describe situations where findings support a conclusion that the narrative objective is met.

> **Baseline:** Not applicable.
> **Alternative 1:** Do not include process figures in the Draft Part 1.
> **Alternative 2:** Include process figures in the Draft Part 1

Proposed Language: See Appendix A, Figures 1 and 2.

6.0 ENVIRONMENTAL EFFECTS OF THE DRAFT PART 1

6.1 REGULATORY REQUIREMENTS

This section presents the regulatory requirements for assessing environmental impacts under CEQA for the proposed *Water Quality Control Plan for Enclosed Bays and Estuaries of California Part 1 Sediment Quality* (Part I). Part I (Appendix A) is evaluated at a program level of detail under a certified regulatory program. As described in Section 1.5, state agencies are subject to the environmental impact assessment requirements of CEQA . However, CEQA authorizes the Secretary of the Resources Agency to exempt specific State regulatory programs from the requirements to prepare Environmental Impact Reports (EIRs), Negative Declarations, and Initial Studies, if certain conditions are met (Public Resources Code, §21080.5). While the "certified regulatory programs" of the State and Regional Water Boards are exempt from certain CEQA requirements, they are subject to the substantive requirements of California Code of Regulations, title 23, section 3777(a). This section requires a written report that includes a description of the proposed activity, an analysis of reasonable alternatives, and an identification of mitigation measures to minimize any significant adverse environmental impacts based on information developed before, during, and after the CEQA scoping process that is specified in California Public Resources Code section 21083.9.

Public scoping meetings were held in San Diego, Oakland and Rancho Cordova in the fall of 2006 to obtain input on the scope of this analysis. Comments received are posted on the Water Boards website at
http://www.waterboards.ca.gov/bptcp/comments_sqo.html.

Section 3777(a) also requires the State Water Board to complete an environmental checklist as part of its substitute environmental documents. This checklist is provided in Appendix B of this document.

In addition, the State Water Board must fulfill substantive obligations when adopting performance standards, including water or sediment quality objectives. Public Resources Code section 21159 provides that an agency shall perform, at the time of the adoption of a rule or regulation requiring the installation of pollution control equipment, or a performance standard or treatment requirement, an environmental analysis of the reasonably foreseeable methods of compliance. The statute further requires that the environmental analysis, at a minimum, include all of the following:

- An analysis of the reasonably foreseeable environmental impacts of the methods of compliance.
- An analysis of reasonably foreseeable feasible mitigation measures to lessen the adverse environmental impacts.
- An analysis of reasonably foreseeable alternative means of compliance with the rule or regulation that would have less significant adverse impacts. (Pub. Resources Code, § 21159(a).)

6.2 DESCRIPTION OF ANALYSIS

Public Resources Code §21159(d) specifically states that the public agency is not required to conduct a "project level analysis." Rather, the project level analysis must be done by the lead agency that is required to comply with or implement the performance standard. Neither the State Water Board nor the Regional Water Boards can specify the manner of compliance with their regulations under Water Code §13360. Rather, the lead agency charged with complying with or implementing the standard must conduct a project-level environmental review based on the particular compliance strategy.

Instead, this CEQA document represents a program level environmental analysis of the draft Part 1 proposal. The document analyzes the reasonably foreseeable environmental impacts of the reasonably foreseeable methods of compliance with the draft proposal. In conducting the program-level analysis, the State Water Board is not required to engage in speculation or conjecture. Reasonably foreseeable methods of compliance with the draft proposal may include additional controls, remediation or the development of TMDLs to restore sediment quality. The corrective actions that require additional controls and or remediation will require a project level CEQA analysis (Pub. Res. Code § 21159.2.).

This analysis is based on the description of the environmental setting and existing conditions in Section 3, the regulatory baseline described in Section 4, the incremental changes that could result from the adoption of Part 1, the reasonably foreseeable environmental impacts associated with the reasonably foreseeable methods of compliance with the draft proposal, and reasonably foreseeable mitigation measures and alternatives.

As explained previously, the State Water Board's proposed program consists of the adoption of SQOs that address direct effects on benthic communities and indirect effects on human health of toxic pollutants in bays and estuaries. The primary outcome of this program will be the adoption of scientifically-defensible and environmentally-protective SQOs that can be consistently implemented throughout the state. As discussed in Section 4, the all coastal Regional Water Board basin plans currently contain narrative water quality objectives for toxicity or toxic substances, pesticides, bioaccumulation, or a combination of these that apply to sediment quality. In addition, existing basin plan prohibitions and numeric objectives and criteria for toxic pollutants, for example, the CTR criteria, affect sediment quality. Sediment cleanup and remediation programs are underway or planned in many regions because the sediments do not achieve the applicable objectives or other applicable requirements. These regulatory controls and activities would continue in the absence of this program. The extent to which additional controls on pollutant sources or additional remediation would be required under the proposed program, over the current baseline, is very difficult to determine. This analysis, nevertheless, assumes that adoption of Part I could potentially result in incremental controls or remediation activities over the current baseline.

If Part I is adopted, significant adverse environmental impacts are unlikely to occur from the Part 1 requirements for sampling, testing, sediment quality assessment, or stressor identification. If, however permittees or responsible parties are required to institute additional controls or corrective actions to comply with the proposed aquatic life SQOs for bays, over baseline conditions, these actions could result in potentially significant environmental impacts.

No potential significant adverse environmental impacts, over baseline conditions, are reasonably foreseeable if the proposed human health objective is adopted. Currently, waters are listed under CWA §303(d) as impaired if fish tissue advisory levels or other criteria are exceeded, and the levels or criteria are based on human health risk assessments. The proposed policy continues to use this approach.

Under Part I, compliance with the proposed aquatic life SQO for estuaries would be based on comparing coupled biological effects and chemistry data to reference site conditions. Due to a lack of existing coupled data and known reference sites, staff is unable to determine whether adoption of the proposed objective could result in potentially significant adverse environmental impacts. As noted above, the State Water Board is not required to engage in speculation. Nevertheless, the additional controls or corrective actions, if any, over baseline conditions, stemming from adoption of the proposed objective for estuaries would likely be the same controls and actions required to comply with the proposed aquatic life objective for bays.

This report analyzes the reasonably foreseeable methods of compliance with Part I. This analysis takes into account the knowledge and understanding of baseline conditions and current Regional Water Board actions to restore beneficial uses. For example, it is not reasonably foreseeable that a project proponent would propose or that the Regional Water Board would approve, dredging and disposal of sediment from an entire water body as a result of sediment in the waterbody failing to meet a SQO. Dredging of this magnitude would be environmentally and economically infeasible. In the existing TMDL program, even legacy pollutants, those that are no longer in regular use or production, such as DDT, PCBs and mercury, are being controlled through means other than waterbody-wide dredging. Nor would staff anticipate a need for new wastewater treatment plants. All POTWs are required by the CWA to meet secondary treatment standards and many inland dischargers have or are in the process of upgrading to tertiary treatment. In addition, POTWs that discharge to bays and estuaries must comply with stringent CTR toxic pollutant criteria, which are implemented under the State Water Board's SIP, and must meet U.S. EPA's existing pretreatment program requirements. It is, therefore, unlikely that major modifications to existing POTWs or new POTWs would have to be constructed to meet the SQOs.

6.3 SUMMARY OF BASELINE CONDITIONS

Section 4 described the authority and means by which the State and Regional Boards initiate action to restore and protect beneficial uses through the control of existing discharges causing or contributing to the impact and/or the remediation of the impacted media itself by responsible parties. Currently, the risk to beneficial uses is evaluated based upon water, sediment and tissue data, which is compared to water quality criteria and objectives for priority pollutants in the CTR and basin plans, other numeric and narrative water quality objectives and prohibitions contained in basin plans, and other water quality control plans and policies, such as the 303(d) Listing Policy.

Section 3 described the beneficial uses designated for enclosed bays and estuaries that are impaired based upon the State Water Boards 303(d) List and/or designated as a Toxic Hotpots. Over one hundred segments are listed in bays and estuaries as a result of water-column, sediment or fish tissue-based impairments (Tables 3.1 –3.16). There are also a number of sediment quality-related 303(d) listings for waters upstream of affected bays and estuaries. Impaired sediments can be carried downstream and settle into bays and estuaries, contributing to existing impairments or causing new ones. Unless de-listing occurs, all of these segments will require development of a TMDL to restore the beneficial use. The types of actions taken by permittees to comply with permit limits or wasteload allocations include additional pollution prevention education and awareness, modifications to pretreatment programs, construction or implementation of new BMPs or modification to existing BMPs, or process optimization or construction of additional treatment works.

Many Toxic Hotpots have been designated as 303(d) listed segments, however if existing sources are not contributing to the impairment, the extent of the impact is relatively localized and the listed segment or hotspot is significantly impacting beneficial uses, Regional Water Boards may require the area to be remediated. The types of action currently implemented by responsible parties to comply with cleanup and abatement orders include removal actions, capping and sequestering, in-situ remediation, natural attenuation or by other means described in the Consolidated Toxic Hotspots Cleanup Plan Amended Final Functional Equivalent Document (SWRCB 2004a).

6.4 INCREMENTAL IMPACTS ABOVE BASELINE CONDITIONS

If waters are identified as impaired because they fail to comply with the proposed SQOs, remediation activities or source control, or both, will be required to bring them into compliance. Many bays and estuaries are currently listed for sediment impairments and require controls under baseline conditions. Incremental sediment remediation, over baseline conditions, would be required under the proposed Part 1 only if monitoring data revealed biological impacts 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 Part 1 would also exceed current objectives. To the extent that results differ, it is possible that the additional assessment activities under the draft Part 1 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 highly impacted localized sites affected by historical pollutants with no known, ongoing sources.

A review of available data and existing listings indicates that there is insufficient data to assess compliance with the SQOs for several enclosed bays and all estuaries. For enclosed bays with sufficient data, the review indicates that there are potentially eight bay segments that are not currently on the state's 303(d) list for sediment toxicity-related impacts for which the MLOE data indicates impairment under the draft Part 1. Under baseline conditions, it is possible that the Regional Water Boards could identify these segments as impaired based upon existing narrative objectives even in the absence of Part 1. It should be noted that the Regional Water Boards identified the need for sediment cleanup and remediation for three of the eight segments under BPTCP. Assuming, however, that stressor identification and TMDL development are required for these segments under the draft Part 1 and that these activities would not be pursued under baseline conditions, sediment remediation or other cleanup activities would be necessary.

In addition to the eight segments discussed above, the review indicated that three segments, which are currently listed on the 303(d) list for sediment-related degradation

under the baseline, would not be impaired under Part 1. Adoption of Part 1 would result in cost savings for these sites.
Additional pollution control activities for on-going discharges under the proposed Part 1 could be required if the concentration of pollutants in discharges had to meet levels more stringent than required to achieve compliance with existing water quality objectives. Moreover, additional controls might be required to address previously unidentified chemical stressors. Without being able to identify the particular pollutants causing biological effects, however, or to determine the discharge concentrations necessary to achieve the proposed SQOs, it is difficult to determine whether, and to what extent, additional remediation or control activities will be necessary.

Assuming that additional controls on pollutant sources are necessary, the controls will likely focus on storm water sources, marinas, and wetlands. The degree to which incremental controls on these sources, over baseline conditions, would be required is uncertain. In any event, the reasonably foreseeable methods of compliance for storm water sources include increased or additional nonstructural and structural BMPs. For marinas and boating activities, reasonably foreseeable methods of compliance include the use of less toxic paint on boats and the use of containment or recovery equipment during hull maintenance activities. Wetlands controls may include aeration, channalization, revegetation, sediment removal, levees, or a combination of these practices.

6.5 PROGRAM ALTERNATIVES

Section 5 identified a series of issues and alternatives considered in the development of draft SQOs and the Draft Part 1. Of those Issues Staff have considered the following in this Tier I Programmatic Analysis:

1. No project alternative as described in Section 5.1.1
2. Selection of receptors as described in Section 5.3.2
3. The number of LOE as described in Section 5.5.1
4. Selecting alternative designation for the protected condition described in Section 5.6.1
5. The staff proposed draft Part 1 that protects specific receptors and utilizes MLOE to interpret the narrative objectives. The rationale and information supporting this approach that forms the foundation for the Draft Part 1 is described in Section 5.

No project alternative
Section 5.1.1 described the legal mandate that the State Water Board adopt SQOs. The State Water Board is bound by chapter 5.6 and the amended Settlement Agreement to develop and adopt SQOs. For this reason, the no project alternative is not feasible and is not considered further in this analysis.

Section of Alternate Receptors
The strengths and limitations of various receptors are examined in detail in Section 5.3.2. Although all receptors are important, the selection of receptors was based upon the type and magnitude of exposure based upon the life history of the organism, the ecological significance, sensitivity and response and the ability to evaluate the health of the receptor relative to pollutants in sediment. Selection of inappropriate receptors can have a significant impact on the environment. For instance, the selection of transient

receptors may not respond to pollutants in sediment because the duration of the exposure is limited or the receptor may be exposed in other waterbodies and thus not represent an exposure at the area of concern. The selection of benthic communities and human health are both sensitive, relevant receptors and appropriate for the Draft Part 1

The Number of LOE to Assess Benthic Community Narrative Objective
The State Water Board could propose fewer LOE to support the narrative SQO, however the use of fewer LOE was not supported by the Scientific Steering Committee as an appropriate measure of sediment quality. As explained in Section 5.5.1, each LOE has strengths and weaknesses that must be considered in the application of the LOE as a measure of sediment quality. Through the application of three LOE, the weight of evidence can provide a more confident assessment that minimizes the weaknesses or limitations associated with the individual LOE used alone.

Alternative Designation for the Protected Condition
The selection of the protected condition clearly has significant potential to impact the environment. Staff has recommended that stations designated as Possibly Impacted, Likely Impacted and Clearly Impacted be considered as degraded. As discussed in Section 5.6.1, establishing this classification is consistent with chapter 5.7 , because the Possibly Impacted category represents the lowest level of impact. As described in Section 1.9, the purpose of the SQOs is to provide reasonable protection of beneficial uses, with an adequate margin of safety.

6.6 REASONABLY FORESEEABLE METHODS OF COMPLIANCE

The primary limitation of the proposed SQOs is that the application of the indicators and thresholds to existing MLOE data from bays and estuaries does not provide any direct information on potential cause of an exceedance. Nor does the proposed SQO provide a pollutantspecific concentration that would be protective of aquatic life in sediment. As a result, evaluating reasonable means of compliance is difficult. It is also very difficult to determine whether there will be any reasonably foreseeable adverse environmental impacts stemming from the reasonably foreseeable methods of compliance over the current baseline.

There are an unlimited number of reasonable and foreseeable actions that could be implemented by permittees or responsible parties to comply with the draft Part I. These actions can be categorized by controls that are applicable to the quality of water being discharged and remedial actions that are applied to reduce the risk associated with the pollutants already in the sediment. Controls may include the following:

Non-Structural Controls

- Public Education: Education to promote pollution awareness on the proper use and proper disposal of products containing toxic pollutants, pollution prevention and minimization, and environmental stewardship
- Training: Training programs can be used to support effective use of BMPs
- Water Conservation: Water conservation reduces dry weather runoff that may carry sediment and pollutants directly into enclosed bays and estuaries or rivers draining into these waterbodies.
- Street cleaning (includes sweeping or washing): Frequent or more effective street sweeping or washing can reduce both sediment and pollutant runoff.

Structural Controls

- Detention Basins/Retention Ponds: These ponds and basins can reduce the volume of suspended sediment and pollutants in stormwater by allowing suspended solids to settle out and reduce hydraulic load on the conveyance system.
- Stormwater Diversions: Stormwater diversions have been constructed to divert dry season flows to wastewater treatment plants.
- Vegetated Swales/Buffer Strips: Well maintained buffer strips constructed along roadsides and in medians can reduce the volume of sediment carried to storm drains.
- Removal and Disposal of Polluted Soils: Soil containing toxic pollutant residuals may be removed from sewer lines and excavated out of stormwater channels or conveyances or public rights-of-way.
- Treatment process optimization: Measures wastewater treatment plants can implement to modify or adjust the operating efficiency of the existing wastewater treatment process.
- Pretreatment Program Assessment: Wastewater treatment plants can evaluate the effectiveness of the pretreatment programs and require upstream sources to reduce pollutant loading into the plant influent.
- Treatment Plant Upgrades. Treatment plants may be upgraded to reduce pollutant concentrations in effluent.
- Outfall Modifications: Treatment plants may relocate or redesign an outfall to reduce the potential impacts associated with the discharge of effluent. Redesign may include construction of a multi-port diffuser to increase dilution or relocation of the discharge into a location close to the ocean.

Remedial Actions

Remedial Actions are applied to restore the beneficial uses by reducing the risk of exposure to pollutants in sediment. The types of remedial action, potential environmental impacts and mitigation and relative costs are described in the Consolidated Toxic Hotspots Cleanup Plan Amended Final Functional Equivalent Document (SWRCB 2004a). Potential actions include:

- Capping/Sequestering of Polluted Sediments: If the polluted sediments are not limiting navigation and risk minimization is the objective, a well-engineered cap can reduce the mass of pollutants available for uptake or exposure.
- Dredging: Polluted sediments may be dredged from the water body for offsite disposal or remediation.
- In-situ Remediation
- Natural Attenuation

6.7 POTENTIAL ADVERSE ENVIRONMENTAL EFFECTS

For waterbodies identified as hotspots or placed on the CWA §303(d) list due to impaired sediment quality, the Regional Water Boards currently have the authority to issue and revise waste discharge requirements for ongoing pollutant sources, issue and implement enforcement actions to require remediation of these sites and/or develop TMDLs wasteload and load allocations to restore beneficial uses. Adoption of the Draft Part 1 will not alter this authority nor does adoption of the Draft Part 1 change the physical way in which the sites or waterbodies could be remediated or protected. Adoption of the Draft Part 1 could, however, result in incremental remediation activities or controls, or both, that could have reasonably foreseeable adverse environmental impacts.

Actions taken by the Regional Water Boards in response to sediment exceeding the proposed SQOs could result in degraded or adversely impacted biological resources, at least temporarily, during the construction of controls, treatment works, BMPs, or cleanup and mitigation efforts if these actions are not carefully planned and executed. Other impacts related to air quality, aesthetics, noise, hazardous materials, vehicle or vessel traffic could occur as well. Staff has determined that all of these potential impacts can be mitigated to less then significant levels with mitigation at the project level. When the SQOs are implemented on a project-specific basis, the agencies responsible for the project can and should incorporate the alternatives and mitigation measures into the project or project approvals.

Finally, it should be noted that the Draft Part 1 and management actions that occur as a result of adoption of the Draft Part 1 are intended to protect and restore the beneficial uses within bays and estuaries of California.

6.8 GROWTH-INDUCING IMPACTS

CEQA defines the expected discussion of growth-inducing impacts and indirect impacts associated with growth in section 15126(g) of the CEQA guidelines. That section states: "...*Discuss the ways in which the proposed project could foster economic or population growth, or the construction of additional housing, either directly or indirectly, in the surrounding environment. Included in this are projects that would remove obstacles to population growth (a major expansion of a wastewater treatment plant might, for example, allow for more construction in service areas). Increase in the population may further tax existing community service facilities so consideration must be given to this impact. Also discuss the characteristics of some projects which may encourage and facilitate other activities that could significantly affect the environment, either individually or cumulatively. It must not be assumed that growth in any area is necessarily beneficial, detrimental, or of little significance to the environment."*

The draft Part 1 provides consistent approach to assess sediment quality relative to the narrative SQOs. The analysis of environmental impacts concludes that the draft Part 1 will not have a significant effect on the environment. The draft Part 1 is not expected to foster or inhibit economic or human population growth, or the construction of additional housing.

6.9 CUMULATIVE AND LONG-TERM IMPACTS

No cumulative adverse environmental impacts are expected at the program level from the adoption of Part I. Neither the State nor the Regional Water Boards have previously adopted SQOs. The State Water Board anticipates adopting refined SQOs for direct effects in estuaries and indirect effects in bays and estuaries in Phase II. The cumulative environmental impacts from the adoption of Phase I and Phase II are expected to be beneficial. The adoption of scientifically defensible and protective SQOs will ensure that aquatic life and human health beneficial uses are maintained and protected in coastal bays and estuaries. At the project level, the lead agency will have to analyze whether a compliance project could have environmentally cumulative effects.

This analysis will depend on whether other related or unrelated projects are occurring in the same general time and space as the compliance project. Whether or not any potential significant adverse cumulative impacts could occur at the project level will depend on site-specific information related to the location, timing, and nature of the compliance action.

When considering cumulative and long-term impacts, Staff also considered the draft Part 1 potential contribution to global climate change. The State of California adopted Assembly Bill 32, the Global Warming Solutions Act of 2006. The Act requires the State to reduce its global warming emissions to 2000 levels by 2010 (11% below business as usual), to 1990 levels by 2020 (25% below business as usual), and 80% below 1990 levels by 2050. To that end, this CEQA analysis considers the potential of the proposed sediment quality objectives to impede efforts to achieve the mandated reductions.

Adoption of the proposed sediment quality objectives will not directly contribute to greenhouse gas (GHG) emissions, but consequent implementation of monitoring, clean-up and remediation activities could require the operation of equipment and vehicles that will generate emissions potentially contributing to GHG levels. Emissions from such operations are unknown but are unlikely to be significant when considered in the context of the state emissions inventory. In any event, due to the lack of data on potential emissions and their relative significance on global climate change, the potential cumulative impacts are far too speculative to analyze. At the programmatic level, it is not possible to estimate the number of monitoring and remediation efforts that could be initiated, the equipment or vehicles that might be required, or the locations throughout the state where such actions might be undertaken. Efforts to assess the level of benefits or adverse impacts of such projects would be speculative at this time. Individual projects will be subject to the appropriate level of environmental review at the time they are proposed, and mitigation would be identified as warranted prior to approval.

6.10 POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION

In this section, Staff presents the rationale for the ratings of environmental impacts listed in the CEQA checklist presented in Appendix B and potential means to mitigate the impacts. As used in this analysis and as defined by CEQA (Article 20, Section 15370), mitigation can be divided into four types:

1. Avoiding the impact altogether by not taking a certain action or part of an action.
2. Minimizing impacts by limiting the degree or magnitude of the action and its implementation.
3. Rectifying or eliminating the impact over time by preservation and maintenance operations during the life of the action.
4. Compensating for the impact by replacing or providing substitute resources or environments.

It is likely that all of these mitigation strategies will be used alone or in a variety of combinations to address specific impacts associated with individual projects developed to restore or protect beneficial uses related to sediment quality.

It should be noted that the Draft Part 1 does not mandate any actions or projects that would lead to significant, permanent, negative impacts on the environment. However, this analysis also considers the reasonably foreseeable potential adverse environmental impacts stemming from the reasonably foreseeable methods of compliance with Part I, including additional controls or remediation or the development of TMDLs. Staff anticipate that all reasonably foreseeable potential environmental impacts will be mitigated to less-than-significant levels through a project-specific CEQA analysis, the Water Board's regulatory and permitting process or through other agencies with jurisdiction in relevant areas, such as U.S. EPA, USFWS, NMFS, OSHA, USACE, CDFG, DTSC, California Coastal Commission and San Francisco Bay Conservation and Development Commission (BCDC).

AESTHETICS

Failure to meet the objectives could potentially result in construction activities for additional treatment works, BMPs, and use of land or vessel-based heavy equipment for all projects involving dredging or construction activities. Thus, reasonably foreseeable short term impacts could occur during construction related activities. No long term impacts are anticipated that would result in substantial physical changes to the environment, including light or glare that would affect aesthetics. Construction activities could be limited to spring, fall, and winter week-days to avoid disrupting recreational, pleasure boating or site-seeing activities associated with the summer tourist season.

AGRICULTURAL RESOURCES

Significant impacts would occur if a project substantially affected agricultural lands or production processes. There are no known or reasonably foreseeable impacts to agricultural resources due to the proposed adoption of the Draft Part 1. Furthermore, the Draft Part 1 relies on the Regional Water Boards' Irrigated Lands Programs to determine how the SQOs will be implemented for those specific agricultural discharges that drain into bays and estuaries.

AIR QUALITY

Failure to meet the proposed objectives could potentially result in construction activities for treatment works, BMPs, and use of land or vessel-based heavy equipment for all projects involving dredging or construction activities. Emissions from this equipment vehicles and vessels have the potential for temporary adverse effects to air quality. The primary pollutants of concern in these emissions are NOx or nitrogen oxides. NOx are precursors to ozone formation, and many of the major embayments and the Sacramento San Joaquin Delta are located in areas designated as nonattainment areas for ozone. Other emissions of concern could be carbon monoxide and PM_{10} (particulate matter < 10 microns). Potential air quality impacts can be mitigated by operating equipment under permit, use of electric dredging equipment, planning the project for the time of year or day when emissions would be least likely to cause an exceedance of air quality standards, optimizing the mode of transportation, favoring disposal sites closer to dredge sites, and minimizing the number of trips necessary to transport dredged material to the disposal site or rehandling facility. Mitigation of air quality impacts will be considered under CEQA for each specific project.

BIOLOGICAL RESOURCES

Failure to meet the proposed objectives could potentially result in construction activities for treatment works, BMPs, and use of land or vessel-based heavy equipment for all projects involving dredging or construction activities. On land, there are no reasonably foreseeable impacts to biological resources from adoption of the draft Part 1. The removal of soil could occur as part of land-based corrective action and control activities; however, many toxic pollutants found in sediments are typically found in highly urbanized, industrial areas where the presence of sensitive native species and habitats are improbable. Measures designed to intercept, divert, treat, and convey urban runoff to municipal wastewater treatment systems are only likely to occur at strategic locations in highly urbanized areas where the runoff requires additional controls.

In water, dredging, disposal, and capping all have the potential to cause adverse effects to biological resources in several ways: short-term habitat destruction and displacement of sensitive species, possibly during critical periods such as nesting, disturbance of sensitive spawning or migrating fish species due to turbidity, and "take" of endangered species.

Specific mitigation measures include adherence to established work windows to time dredging activities to avoid key seasonal activity of anadromous fish and bird species that inhabit nearshore areas either seasonally or year-round; use of electric dredge equipment; use of environmental (closed) clamshell buckets on dredges; and noise dampening material on equipment. Identification and mitigation of impacts to biological resources would be determined under CEQA for each specific project in consultation with the DFG and the USFWS.

CULTURAL RESOURCES

Staff is not aware of any cultural resources present beneath subtidal sediments in bays and estuaries that could potentially be impacted through the adoption of the draft Part 1. However, our lack of awareness does not preclude the possibility of previously unmapped cultural resources in near-shore locations that could be impacted by activities in response to exceedance of the narrative SQOs. As a result, any future actions that could impact cultural resources would be subject to CEQA on an individual case-by-case basis, and evaluated at that time.

GEOLOGY and SOILS

Significant impacts to geology and soils would occur if a project exposed people or structures to potential, substantial adverse effects related to rupture of a known earthquake fault, other seismic events, or landslides. Significant impacts would also occur if a project caused substantial erosion or was located in areas with unsuitable soils or landslide-prone conditions. Although the Draft Part 1 does not mandate any specific remediation or corrective action, failure to meet the proposed objectives could potentially result in construction activities for treatment works, BMPs, and use of land or vessel-based heavy equipment for all projects involving dredging, excavation or construction activities. Dredging activities have the potential to destabilize channel slopes and undermine pilings. Standard engineering practices such as installation of sheet pile walls at the toe of the shore slope would reduce or avoid this impact.

HAZARDS and HAZARDOUS MATERIALS

This category refers to chemicals that have been discharged to the environment that may adversely impact the environment or human health and safety. Soil and groundwater impacted by such chemicals are also included. Significant impacts would occur if a project led to increased hazards to the public or environment from transport, handling, or emissions of such materials. Also included are projects located near airports and listed hazardous materials sites.

Failure to meet the proposed objectives could potentially result in construction activities for treatment works, BMPs, and use of land or vessel-based heavy equipment for all projects involving dredging or construction activities. For these situations, potential impacts related to hazardous materials can be mitigated to less than significant levels with appropriate mitigation measures. In any action involving toxic pollutants, there is a potential for release of pollutants due to an accident or upset condition. The potential for such releases can be greatly reduced by proper planning. Measures to prevent releases of toxic pollutants include such things as pollution prevention technology (e.g., automatic sensors and shut-off valves, pressure and vacuum relief valves, secondary containment, air pollution control devices, double walled tanks and piping), access restrictions, fire controls, emergency power supplies, contingency planning for potential spills and releases, pollution prevention training and other types of mitigation appropriate to the cleanup plan.

Trucking hazardous wastes through neighborhoods has the potential to result in the possibility of fire or explosion; exclusion of hazardous waste from certain neighborhoods; inability to get bridge-crossing permits in a timely manner may limit the feasibility of remedial measures. It may be necessary to select a remediation measure such as capping to avoid such hazards. Fuels, lubricating oils, and other petroleum products will be used during cleanup activity. Well-established techniques for controlling spills, leaks, and drips will be incorporated in the work plans to assure the control of petroleum products and any other chemicals used during the cleanup activity.

Project workers and supervisors are required to comply with applicable Occupational of Health and Safety Administration (OSHA) training requirements for site clean-up personnel. In addition, site-specific health and safety plans would be prepared in accordance with California Code of Regulations, tit. 8, §5L92 and 29 C.F.R. § 1910.120, which govern site clean-up.

Potential management and remedial actions could include handling and transport of equipment, debris, scrap materials, soil and sediment containing potentially hazardous material. To protect people and the environment from potential impacts, the hazardous material must be handled, transported, and stored in accordance with applicable laws and regulations.

HYDROLOGY and WATER QUALITY

Significant impacts to hydrology and water quality would occur if a project substantially alters existing drainage patterns, alters the course of a river or stream, violates water quality standards, or creates or contributes to runoff that would exceed the capacity of local stormwater drainage systems. Significant impacts would also occur if a project placed housing or other structures within the 100-year flood plain, or exposed people or structures to significant risks from flooding, seiches, or tsunamis.

Failure to meet the proposed objectives could potentially result in construction activities for treatment works, BMPs, and use of land or vessel-based heavy equipment for all projects involving dredging or construction activities.

Dredging equipment can cause turbulence in the water body, and, thus, the dredging process can cause short-term adverse impacts to water quality from turbidity or from stirring up pollutants in the sediment. These impacts can be regulated through WDRs and can be reduced by requiring use of dredging equipment or operations that minimize the discharge of chemical pollutants during dredging (e.g., use of clam shell dredger, etc.), use of settling tanks to reduce excessive turbidity in discharge, use of silt curtains to reduce dispersal of the turbidity plume beyond the dredge site, coffer dams in small channels, and accurate positioning of disposal equipment during dredging. DFG also has dredging regulations to protect against adverse biological impacts.

Some control or remedial actions could occur on the shoreline. Depending on the cleanup method selected for the shoreline activity, minor changes in absorption rates, drainage patterns, and the rate of surface runoff may change. On land, excavation can be mitigated by performing all work during the dry season and using BMPs for the control of erosion.

In addition, runoff from construction of BMPs, treatment works, excavation activities, or disposal of dredged materials above sea level can adversely affect surface water quality. Impacts from these activities can be reduced by doing work during the dry season or by implementing BMPs to reduce erosion. Most local governments also have erosion control ordinances and grading ordinances.

Stormwater diversions intended to improve water and sediment quality are not expected to degrade receiving water quality, rather these actions would improve water and sediment quality by means of additional treatment.

Changes in bottom contours brought by dredging or capping would probably have minimal effects on water circulation if properly managed. Relatively small areas are under consideration for modification at most of the sites. At larger sites, removal and placement will attempt to retain regional bottom depth and contour, except where bathymetry is planned for environmental improvement.

LAND USE AND PLANNING
Significant impacts to land use and planning would occur if a project physically divided a community, conflicted with a land use plan, policy or regulation, or caused conflict with a habitat conservation plan. General plans and zoning delineate those areas that will be developed, and the type and density of development to be allowed. There is nothing in the Draft Part 1 that requires the properties to be used in any way.

MINERAL RESOURCES
Significant impacts to mineral resources would occur if a project resulted in the loss of a mineral resource of value locally, regionally, or statewide. There is no evidence that the adoption of the draft Part 1 would result in the loss of a known mineral resource or availability of the mineral resources.

NOISE
Significant impacts from noise would occur if a project exposed people to noise or groundborne vibration in excess of established standards in a local general plan or noise ordinance or resulted in a substantial permanent increase to ambient noise levels. Significant impacts can also occur if a project causes substantial temporary or periodic increases in noise or if a project is located in the vicinity of an airport and would expose people residing or working in the project area to excessive noise levels.

Although the draft Part 1 does not mandate any specific remediation or corrective action, failure to meet the objectives could potentially result in short-term noise related to construction activities and use of land or vessel-based heavy equipment for all projects involving dredging or construction activities. Mitigation would consists of compliance with local noise ordinances (typical standards include blackouts prohibiting use of heavy equipment on Sundays, early morning hours and evenings all week, and on holidays), use of noise dampening material or barriers around equipment, locating equipment as far as practical from noise-sensitive areas and selecting haul routes that affect the lowest number of people. These alternatives would be considered under CEQA for each specific project.

POPULATION AND HOUSING
Significant impacts to population and housing would occur if a project substantially encouraged population growth, displacing substantial numbers of people from existing housing and thereby necessitating construction of replacement housing elsewhere. Adoption of the Draft Part 1 will not result in the need for more housing or displace residents in existing communities. See discussion of growth-inducing impacts in Section 6 and Section 13241 factors in Section 7.

PUBLIC SERVICES
Significant impacts to public services would occur if a project resulted in substantial physical impacts as a result of requirements for increased public services such as police, fire protection, schools, or other public facilities. Adoption of the Draft Part 1 will not result in the need for new government services for fire or police protection, education, or maintenance of public services.

RECREATION
Significant impacts to recreation would occur if a project increased the use of existing park facilities such that physical impacts occurred if a project included construction or expansion of park facilities leading to physical impacts. Adoption of the Draft Part 1 would not create additional demand for parks or recreational facilities, but would have a positive impact on existing recreational opportunities such as fishing and swimming.

TRANSPORTATION / CIRCULATION
Significant impacts to transportation and traffic would occur if a project caused a substantial increase in traffic in relation to existing traffic load/capacity of the existing street system, exceeded established level of service standards, resulted in change in air traffic patterns, lead to increases in road-related hazards, resulted in inadequate emergency access or parking. Adoption of the Draft Part 1 would not create additional vehicle or air traffic, or alter traffic patterns. Remediation of contaminated sediments may temporarily alter vessel traffic that would require approval from port authorities, Harbor Master and U.S. Coast Guard. However these impacts would be mitigated under CEQA specifically for each project.

UTILITIES AND SERVICE SYSTEMS
Significant impacts to utilities and service systems would occur if a project exceeded wastewater treatment standards, required construction of new water or wastewater treatment facilities or new or expanded storm water drainage facilities, or a project's water needs exceeded existing resources or entitlements. Significant impacts would also occur if a project was not served by a landfill with sufficient capacity or the project failed to comply with federal, state, or local regulations for solid waste. Although the draft Part

1 does not mandate the construction of wastewater treatment facilities, failure to meet the objectives could potentially result in additional controls and treatment to reduce the discharge of pollutants into waterbodies. As stated previously, it is unlikely that treatment plants that comply with the CWA, the Water Code , the toxic pollutant criteria in the CTR, the implementation provisions in the SIP, and basin plans will cause exceedances of the proposed SQOs and Draft Part 1.

Discharge reductions can be accomplished through (1) treatment process optimization (measures facilities can implement to modify or adjust the operating efficiency of the existing wastewater treatment process - such measures usually involve engineering analysis of the existing treatment process to identify adjustments to enhance pollutant removal or reduce chemical additional); (2) waste minimization/pollution prevention costs (conducting a facility waste minimization or pollution prevention study); (3) pretreatment (conducting study of sources and reducing inflow from indirect discharges); or (4) new or additional treatment systems. For stormwater, implementation of BMPs can also be applied to *reduce* pollutants, rather than treatment of storm water to *remove* pollutants. Because of the nature of storm water discharges, the Water Boards have not typically established numeric effluent limitations for toxic pollutants in storm water permits. The limitations contained in storm water permits are typically narrative and include the requirement to implement the appropriate control practices and/or BMPs. BMPs can range from good housekeeping to structural controls.

6.11 MANDATORY FINDINGS OF SIGNIFICANCE

The results of this analysis demonstrate that the Draft Part 1 if adopted could potentially result in reasonably foreseeable adverse environmental impacts.. There are reasonably foreseeable mitigation measures identified above, and those required by federal, state, and local laws and regulations, that the lead agency responsible for the project level environmental review can and should adopt. These mitigation measures should mitigate any potential adverse impacts at the project level to less than-significant levels.

7. CWC SECTION 13241 AND ANTIDEGRADATION

The State Water Board must analyze the factors described in section 13241 of the Water Code when establishing water quality objectives. Chapter 5.6 requires that the State Water Board adopt SQOs "pursuant to the procedures established by [Division 7] for adopting or amending water quality control plans." (Wat. Code §13393(b).) While the State Water Board is not statutorily required to comply with the substantive requirements for adoption of water quality objectives, when adopting SQOs, the State Water Board has, nevertheless, considered the section 13241 factors. In addition, the State Water Board must ensure that its actions are consistent with Resolution No. 68-16, the state's antidegradation policy.

7.1 PAST, PRESENT, AND PROBABLE FUTURE BENEFICIAL USES OF WATER.

The proposed SQOs address:

3. Benthic communities exposed directly to pollutants in sediment.
4. Human health exposed indirectly through fish and shellfish tissue.

As a result these objectives will protect sediment quality for all the beneficial uses that focus on these specific receptors and the associated exposure pathways. The proposed SQOs and interpretive tools will compliment and support the Water Boards' existing water quality control plans and policies, and provide a better means to ensure that beneficial uses are protected.

7.2 ENVIRONMENTAL CHARACTERISTICS OF THE HYDROGRAPHIC UNIT UNDER CONSIDERATION, INCLUDING THE QUALITY OF WATER THERETO.

The indicators proposed to interpret the narrative objective protecting benthic communities were developed based upon the specific physical, environmental biological characteristics of these waters. Unlike many of the numeric criteria in the CTR or used in the development of national sediment quality guidelines, very little data collected from outside the state was used in the development and validation of each indicator. For this reason, all the indicators proposed in this draft Part 1 exhibit better performance in general than indicators developed from national studies, and, as a result, better protect the beneficial uses in waters of the State.

The implementation language proposed in the draft Part 1 provides direction on how the SQOs shall be implemented within the regions, however within the draft Part 1 each Regional Water Board retains the authority and flexibility to apply the SQOs in the appropriate regulatory program. The draft Part 1 does not describe how a particular site should be corrected or remediated. Selection of corrective action can be addressed only after many site-specific factors are considered such as:

- The hydrodynamics and flow regime in the area of concern
- The specific pollutant that is causing the degradation or impairment
- The receptors at risk due to the presence of the pollutants at the levels observed within the area of concern.

- The aerial extent
- Presence of existing sources or legacy releases
- Types of controls in place and feasibility of additional controls

7.3 WATER QUALITY CONDITIONS THAT COULD REASONABLY BE ACHIEVED THROUGH THE COORDINATED CONTROL OF ALL THE FACTORS WHICH AFFECT WATER QUALITY IN THE AREA

As described in Section 1, wastes have been discharged into bays and estuaries either directly as point sources, indirectly as runoff, or accidentally through releases and spills for many years. In addition, many contaminants readily attach to the sediments and are carried down rivers and creeks contributing to the contaminant loading. Once these sediments reach the bays and estuaries, poor flushing and low current speeds allow the sediments and contaminants to settle before reaching the open ocean.

The State and Regional Water Boards are required to ensure that all discharges, regardless of type, comply with all water quality control plans and policies. If the SQOs are adopted into a permit as receiving water limits, the discharge must meet the limits or, if the limits are not being met due to the discharge of toxic pollutants, determine the causative pollutant. If the discharger is contributing to the accumulation of the pollutant causing the degradation, the permittee would be required under existing authority to control the pollutant to the extent practical through BMPs or additional treatment. The same approach would occur if mutiple discharges are contributing to the accumulation of the pollutant. For additional control measures see **Controls** under economic considerations

7.4 ECONOMIC CONSIDERATIONS.

the Water Boards must consider economic factors in establishing water quality objectives. Generally, this analysis entails consideration of whether the objectives and alternatives are currently being attained, the methods available to achieve compliance, and the costs of those methods. In addition, the Water Boards must consider economic factors under Public Resources Code §21159 when adopting rules that establish performance standards or treatment requirements.

For the proposed SQOs, the available compliance methods and costs depend on the types of sources that may be affected by the SQOs, which could include a variety of point and nonpoint sources. In order to assess the economic impacts of the proposed objectives and Part 1, DWQ staff consulted with Scientific Applications International Corporation (SAIC). More details of the economic considerations given here may be found in the report "*Economic Considerations of Sediment Quality Plan for Enclosed Bays in California"* (SAIC 2007).

INCREMENTAL IMPACT OF THE PART 1

The incremental economic impacts of Part 1 include the cost of activities above and beyond those that would be necessary in the absence of Part 1 under baseline conditions, as well as the cost savings associated with actions that will no longer need to occur. Baseline conditions include current objectives and policies regulating activities and pollutant discharges that affect sediment quality (e.g., narrative Basin Plan objectives, CTR criteria, and other policies), existing monitoring programs, ongoing cleanup and remediation activities, and planned or anticipated cleanup and remediation actions that have not yet been completed [e.g., TMDL development and implementation schedules].

Under Part 1, Regional Water Boards would list sediment as exceeding the SQOs if multiple lines of evidence (with sufficient data) indicate impairment. This requirement for additional evidence of impairment could potentially reduce the number of water bodies that would be incorrectly listed as impaired for toxic substances. Potential costs or cost savings associated with implementing the SQOs depend on the relative stringency of the objectives. Table 7.1 indicates the different incremental impacts that could occur under Part 1.

Table 7.1 Incremental Impacts Associated with Part 1

Assessment Under Existing Objective	Assessment Under Proposed SQOs	
	No Sediment Impairment	**Sediment Impairment**
No Sediment Impairment	• No change in sediment quality. • Potential incremental assessment costs.	• Sediment quality improvement. • Potential incremental assessment and control costs.
Sediment Impairment	• Sediment quality remains the same as now, 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 information leads to a change in control strategies. • Potential incremental assessment costs; potential incremental costs or cost-savings depending on differences between control strategies.

Under Part 1, compliance with the proposed aquatic life objective for estuaries would be based on comparing coupled biological effects and chemistry data to reference site conditions. Due to a lack of existing coupled data and known reference sites, an analysis of potential incremental impacts is not possible at this time. The State Water Board will adopt a final direct effects objective for estuaries under Phase II. Thus, it is likely that any control actions identified for compliance with the interim objective would not be implemented until it could be shown that those actions would also be required for compliance with final objective.

Compliance with the proposed human health objective under Part 1 would be based on a human health risk assessment that utilizes OEHHA policies for fish consumption as well as other fish tissue threshold values. In the absence of Part 1, waters will continue to be listed as impaired based on exceedances of fish tissue advisory levels or criteria. Because these same levels and criteria will be used under Part 1 to determine compliance with the objective there would be no incremental impacts associated with the interim human health SQO.

For the proposed aquatic life objective, the Southern California Coastal Water Research Program (SCCWRP) used the assessment matrices in Part 1 to determine compliance at sites for which available sediment monitoring data includes all three of the required sample types (toxicity, chemical exposure, and benthos community). To estimate incremental impacts of Part 1, these results can be compared to existing assessments [i.e., 303(d) listings] for the pollutants of concern in sediment, fish tissue, or the water column. This data is insufficient to determine compliance for all bays. However, for those for which data is available, the results indicate both potential incremental impairments and reduced listings, depending on the water body.

Monitoring and Assessment

The comparison of available assessment data and existing impairments indicates that there is insufficient data to assess compliance with the proposed SQOs for a number of bays, as well as estuaries. In addition, for those waters with sediments that exceed the proposed SQOs, Part 1 indicates that further investigation into stressor identification is necessary (SWRCB, 2006). Thus, the incremental impacts of Part 1 include monitoring and stressor identification costs. Although data for some parameters may not be needed at each sampling site or for each bay, potential per sample costs may range from $3,940 to $5,810 as shown in Exhibit 7-2.

Table 7.2. Potential Sampling Costs under the Plan

Parameter	Cost per sample
Metals suite	$175 – $225
Total Mercury	$65 – $135
PAH suite	$400
Chlorinated pesticides	$200 – $575[a]
PCB congeners (not coplanar)	$200 – $575[a]
Sediment toxicity (acute lethal)	$800
Sediment toxicity (sublethal)	$800 – $1,400
Benthic survey	$800 – $1,200[b]
Sediment collection on boat	$500[c]
Total cost per sample	$3,940 – $5,810

Source: Chemistry cost estimates obtained from price lists used for southern California and San Francisco Bay regional monitoring programs; sediment toxicity and benthic survey costs obtained from southern California regional monitoring program and development of the Plan; sediment collection estimate from SCCWRP (2007).
a. High estimate represents low detection limit analyses.
b. High estimate represents difficult to sort samples, such as 0.5 mm mesh screen samples in San Francisco Bay.
c. Includes the cost of the boat, crew, and any activities associated with preparing the samples for transport to the analysis laboratory (e.g., compositing and subsampling and screening of benthic samples to remove excess sediment).

The number of stations needed to assess bay sediment quality will vary based on site-specific factors. Based on between 5 and 30 samples per bay, depending on area, statewide monitoring costs to assess those bays for which existing data are insufficient (a total of 131 samples representing20,000 acres) may range from $516,000 to $762,000. . These estimated costs by water body are presented in Table 7.3. Costs associated with confirmatory monitoring for segments with only possibly impacted sites (no clearly or likely impacted sites) would be $8,000 to $12,000. A more detailed description of the assumptions and basis used to develop these costs are described in the report by SAIC (2007).

Table 7.3 Potential Incremental Sediment Quality Monitoring Costs

Water Body	Size (Acres)	Number of Samples	Total Monitoring Costs (Low)[1]	Total Monitoring Costs (High)[2]
Region 1				
Crescent City Harbor	374	5	$19,700	$29,100
Bodega Bay	822	12	$47,300	$67,700
Region 2				
Drakes Estero Bay	12,780	30	$118,200	$174,300
San Francisco Bay, Richardson Bay	2,439	12	$47,300	$67,700
Half Moon Bay	355	5	$19,700	$29,100
Region 3				
Moss Landing Harbor	79	5	$19,700	$29,100
Monterey Harbor	76	5	$19,700	$29,100
Santa Barbara Harbor	266	5	$19,700	$29,100
Region 4				
Ventura Harbor	179	5	$19,700	$29,100
Port Hueneme Harbor	65	5	$19,700	$29,100
King Harbor	105	5	$19,700	$29,100
Los Angeles Harbor Consolidated Slip	36	5	$19,700	$29,100
Los Angeles Harbor - Cabrillo Beach	156	5	$19,700	$29,100
Region 8				
Bolsa Bay	116	5	$19,700	$29,100
Region 9				
Mission Bay	2,032	12	$47,300	$67,700
San Diego Bay, Shoreline, at Marriott Marina	32	5	$19,700	$29,100
San Diego Bay, Shoreline, Chula Vista Marina	49	5	$19,700	$29,100
Total	19,961	131	$516,200	$761,700

Detail may not add to total due to rounding.
1. Equals the number of samples times the low estimate of cost per sample ($3,940).
2. Equals the number of samples times the high estimate of cost per sample ($5,810).

There are potentially eight bay segments not currently on the 303(d) list for sediment toxicity related impairments for which MLOE data indicate impairment under the Plan. If stressor identification and possible TMDL development activities are needed for those segments and would not be pursued in the future under existing objectives (for three of these segments, MLOE indicate sediment toxicity, and the Regional Board identified sediment cleanup and remediation necessary under the BPTCP), incremental cost could be approximately $8 million. There are also three segments listed for sediment related impairments under the baseline for which MLOE data indicate no impairment under the Plan. Assuming that no stressor identification or TMDL development would be needed for these segments under Part 1, there could be a potential cost savings of $3 million. Thus, the net incremental cost associated with assessment activities could be approximately $5 million (or lower if such costs would be incurred in the absence of the Plan for any of the 3 sites that exhibit sediment toxicity and for which cleanup and remediation actions are necessary).

For estuaries, the State Water Board is collecting data as part of the Phase II effort to develop appropriate tools and thresholds for implementing the SQO. These data can also be used to assess compliance with the final SQO. Thus, additional monitoring may be necessary for those waters not currently being sampled as part of this effort. However, costs of these monitoring efforts cannot be estimated until the data collection effort is complete.

Controls

For waters that Regional Water Boards identify as being impaired under the proposed Part 1, remediation actions and/or source controls will be needed to bring them into compliance. Many bays and estuaries are already listed for sediment impairments and, therefore, would require controls under baseline conditions. When the baseline controls are identical to the ones that would be implemented under Part 1, there is no incremental cost or cost savings associated with Part 1. When the baseline controls differ, there is potential for either incremental costs or cost-savings associated with the Plan.

Because strategies to meet current narrative 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 Part 1, monitoring data would have to indicate biological impacts under the proposed SQOs 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 Part 1 would also exceed current objectives. To the extent that results differ, it is possible that the additional assessment activities under Part 1 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.

For an increased source control cost associated with additional pollution controls under the proposed Part 1, 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 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. 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, 2005).

Thus, without being able to identify the particular pollutants causing biological effects, and the development of discharge concentrations needed to achieve the proposed objectives, the needed cleanups and/or controls to achieve those concentrations are difficult to estimate. Review of existing impairments and TMDL actions for the various bays suggests that incremental impacts may be unlikely. If there are incremental impacts as a result of the Part 1, controls are likely to focus on storm water sources, marinas, and wetlands. However, some level of control for these sources would occur under the implementation plans for existing TMDLs.

For any situation in which these sources are specifically required to control toxic pollutants to levels that are lower than what would be necessary in the absence of Part 1, 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). 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. Wetlands controls may include aeration, channelization, revegetation, sediment removal, levees, or a combination of these practices.

For estuaries, Regional Water Boards need additional data to identify the sources that may need an incremental level of control.

7.5 THE NEED FOR DEVELOPING HOUSING WITHIN THE REGION.

The adoption of Part 1 is not expected to increase the need for housing in the areas surrounding enclosed bays and estuaries of California. The draft Part 1 applies to the protection of subtidal sediments in surface waters.

7.6 THE NEED TO DEVELOP AND USE RECYCLED WATER.

The adoption of Part 1 is not expected to increase the need to develop and use recycled water.

7.7 ANTIDEGRADATION

In 1986, the State Water Board adopted Resolution No. 68-16, entitled “Statement of Policy with Respect to Maintaining High Quality of Waters in California.” The policy expresses the State Water Board’s intent that the quality of existing high quality waters be maintained to the maximum extent possible. Lowering of water quality is allowed only if the lowering is consistent with the maximum benefit to the people of the state, will not unreasonably affect present and anticipated beneficial uses of waters, and will not result in water quality less than that prescribed in applicable policies. Resolution No. 68-16 has been interpreted to incorporate the provisions of the federal antidegradation policy as well, where the federal policy applies.

The federal policy, in 40 C.F.R. §131.12, establishes three tiers of water quality protection and, like Resolution No. 68-16, allows a lowering of water quality for high quality waters only if certain conditions are met. The state and federal antidegradation policies must be considered for a variety of actions, including water quality standards actions.

The State Water Board does not anticipate any lowering of water quality as a result of the adoption of Part I. For the first time, the state will have scientifically-defensible sediment quality objectives for bays and estuaries. These objectives can be consistently applied across the state to assess sediment quality, regulate waste discharges that can impact sediment quality and provide the basis for appropriate remediation activities where sediments are impaired. Adoption of the SQOs, rather than lowering water quality, should result in water quality improvements.

Currently, Regional Water Boards implement a variety of narrative objectives to address sediment quality. The objectives, in general, do not explicitly address sediment quality. The proposed SQOs, on the other hand, are specific to sediments, were developed with data from California waters, have undergone rigorous scientific review, and are intended to protect sediment quality. The proposed SQOs are likely to be more protective, vis-à-vis sediment quality, than current standards.

8.0 GLOSSARY

ACUTE TOXICITY: Short-term lethal response of an organism to a pollutant.

BEST MANAGEMENT PRACTICES (BMPs): Methods, measures, or practices designed and selected to reduce or eliminate the discharge of pollutants to surface waters from point and nonpoint source discharges including storm water.

BMPs include structural and non-structural controls, and operation and maintenance procedures, which can be applied before, during, and/or after pollution producing activities.

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

BINOMDIST: An Excel® function that can be used to calculate the cumulative binomial distribution.

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

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

BIOACCUMULATION FACTOR (BAF): The ratio of contaminant concentration in biota to contaminant concentration in some other matrix. In this report, unless specified otherwise, the term "bioaccumulation factor" refers to wet weight concentration in fish or invertebrate tissue divided by dry weight concentration in sediment.

BIOAVAILABILITY: The fraction of a chemical pollutant or contaminant that can be absorbed by an organism through gills or other membranes, potentially causing an adverse physiological or toxicological response. Bioavailability is dependent on the chemical form of the pollutant in the media, the physical and biogeochemical processes within the media, the route and duration of exposure, and the organism's age, metabolism, size and sensitivity.

BIOTA-SEDIMENT ACCUMULATION FACTOR (BSAF): This is the bioaccumulation factor for tissue vs. sediment, normalized for lipid and organic carbon. BSAF = (tissue contaminant concentration in wet wt. * sediment % organic carbon) / (sediment contaminant concentration in dry wt. * tissue % lipid).
BIOASSESSMENT: Assessment of biological community information along with measures of the physical/habitat quality to determine, in the case of water quality, the integrity of a water body of interest.

BTAG: Biological Technical Assistance Group, a multi-agency group of State and federal ecological and human health risk assessors supported by U.S. EPA responsible for providing technical assistance for Site remediation and mitigation.

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

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

CHRONIC TOXICITY: Sublethal response of an organism to repeated, long-term exposure to a chemical substance. Typical observed endpoints include growth expressed as length and weight.

CALIFORNIA TOXICS RULE (CTR): Numerical water quality criteria established by U.S. EPA for priority toxic pollutants for California’s inland surface waters, enclosed bays, and estuaries.

DEGRADATION OF SEDIMENT QUALITY: Sediment toxicity and changes in benthic community attributes as a result of exposure to toxic pollutants in bedded surficial sediments. Unacceptable risk to human health and wildlife as a result of bioaccumulation from pollutants in bedded surficial sediments that are transported up the aquatic food chain.

DEMERSAL: Organisms that prefer to spend the majority of their time on or near the bottom of a water body.
DIEL: Measurements pertain to measurements taken over a 24-hour period of time.
DREDGED MATERIAL: Any material excavated or dredged from the navigable waters of the United States, including material otherwise referred to as “spoil.”

EFFECTS RANGE-MEDIAN (ERM)/EFFECTS RANGE-LOW (ERL): Sediment quality guidelines based on a biological effects empirical approach. These values represent chemical concentration ranges that are rarely (i.e., below the ERL), sometimes (i.e., between ERL and ERM), and usually (i.e., above the ERM) associated with toxicity for marine and estuarine sediments. Ranges are defined by the tenth percentile and fiftieth percentile of the distribution of contaminant concentrations associated with adverse biological effects.

EFFECT SIZE: Maximum magnitude of exceedance frequency that is tolerated.

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

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

EQUILIBRIUM PARTITIONING APPROACH: Approach used to relate the dry-weight sediment concentration of a particular chemical that causes an adverse biological effect to the equivalent free chemical concentration in pore water and to that concentration sorbed to sediment organic carbon or bound to sulfide. Based on the theory that the partitioning of a nonionic organic chemical between organic carbon and pore water and the partitioning of a divalent metal between the solid and solution phases are at equilibrium.

EQUILIBRIUM PARTITIONING SEDIMENT GUIDELINES: Sediment quality guidelines derived using the EqP approach. When used in conjunction with appropriately protective water only exposure concentration, a resulting guideline represents the sediment contaminant concentration that protects benthic organisms from the effects of that contaminant.

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

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

INDIRECT EFFECTS: Adverse effects to humans and wildlife as a result of consuming prey items exposed to polluted sediments.

INFAUNA: Organisms that live within sediment or substrate.

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

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

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

MAXIMUM CONTAMINANT LEVEL (MCL): The maximum permissible level of a contaminant in water delivered to any user of a public water system.

MAXIMUM TISSUE RESIDUE LEVEL (MTRL): Tissue values developed from human health water quality objectives in the 1997 California Ocean Plan and from the California Toxic Rule as established in the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California. MTRLs are used as alert levels or guidelines indicating water bodies with potential human health concerns and are an assessment tool and not compliance or enforcement criteria. The MTRLs are calculated by multiplying human health water quality objectives by the bioconcentration factor for each substance.

MESOHALINE: Waters ranging in salinity from 5 to 18 psu.

NATIONAL ACADEMY OF SCIENCE TISSUE GUIDELINES: Guidelines established for the protection of predators. Values are suggested for residues in whole fish (wet weight) for DDT (including DDD and DDE), aldrin, dieldrin, endrin, heptachlor (including heptachlor epoxide), chlordane, lindane, benzene hexachloride, toxaphene, and endosulfan either singularly or in combination.

NATIONAL TOXICS RULE: Numerical water quality criteria established by U.S. EPA for priority toxic pollutants for 12 states and two Territories who failed to comply with the section 303(c)(2)(B) of the Clean Water Act.

NONPOINT SOURCE POLLUTION: Sources are diffused and do not have a single point of origin or are not introduced into a receiving stream from a specific outlet. The commonly used categories for nonpoint sources are agriculture, forestry, mining, construction, land disposal, and salt intrusion.

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

OBJECTIONABLE BOTTOM DEPOSITS: An accumulation of materials or substances on or near the bottom of a water body which creates conditions that adversely impact aquatic life, human health, beneficial uses, or aesthetics. These conditions include, but are not limited to, the accumulation of pollutants in the sediments and other conditions that result in harm to benthic organisms, production of food chain organisms, or fish egg development. The presence of such deposits shall be determined by Regional Water Board(s) on a case-by-case basis.

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

PELAGIC: Organisms living in the water column.

PERSISTENT POLLUTANTS: Substances for which degradation or decomposition in the environment is nonexistent or very slow.

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

POLLUTANT MINIMIZATION: Waste minimization and pollution prevention actions that include, but are not limited to, product substitution, waste stream recycling, alternative waste management methods, and education of the public and businesses.

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

POLLUTION PREVENTION: Any action that causes a net reduction in the use or generation of a hazardous substance or other pollutant that is discharged into water and includes, but is not limited to, input change, operational improvement, production process change, and product reformulation (as defined in Water Code Section 13263.3). Pollution prevention does not include actions that merely shift a pollutant in wastewater from one environmental medium to another environmental medium, unless clear environmental benefits of such an approach are identified to the satisfaction of the State Water Board or the Regional Water Boards.

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

PROBABLE EFFECT CONCENTRATION (PEC): Empirically derived freshwater sediment quality guidelines (SQG) that rely on the correlation between the chemical concentration in field collected sediments and observed biological effects. PECs are based on geometric means of various SQG approaches (with matching chemical and toxicity field data) to predict toxicity for freshwater sediment on a regional and national basis.

PROBABLE EFFECTS LEVEL (PELS)/THRESHOLD EFFECTS LEVELS (TEL): Empirically derived sediment quality guidelines based on a biological effects empirical approach similar to ERMs/ERLs. A generalized approach used to develop effects-based guidelines for the state of Florida and others. The lower of the two guidelines for each chemical (i.e., the TEL) is assumed to represent the concentration below which toxic effects rarely occur. In the range of concentrations between the two guidelines, effects occasionally occur. Toxic effects usually or frequently occurs at concentrations above the upper guideline value (i.e., the PEL). Ranges are defined by specific percentiles of both the distribution of contaminant concentrations associated with adverse biological effects and the "no effects" distribution.

RANK CORRELATION: The association between paired values of two variables that have been replaced by their ranks within their respective samples (e.g., chemical measurements and response in a toxicity test).

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

SIMULTANEOUSLY EXTRACTED METALS (SEM): Metal concentrations that are extracted during the same analysis in which the acid-volatile sulfide (AVS) content of the sediment is determined.

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

TOXIC POLLUTANT: As used in this staff report toxic pollutants refers to priority pollutants AS USED

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

TOXICITY REDUCTION EVALUATION (TRE): Study conducted in a step-wise process designed to identify the causative agents of effluent or ambient toxicity, isolate the sources of toxicity, evaluate the effectiveness of toxicity control options, and then confirm the reduction in toxicity. The first steps of the TRE consist of the collection of data relevant to the toxicity, including additional toxicity testing, and an evaluation of facility operations and maintenance practices, and best management practices. A Toxicity Identification Evaluation (TIE) may be required as part of the TRE, if appropriate. (A TIE is a set of procedures to identify the specific chemical(s) responsible for toxicity. These procedures are performed in three phases [characterization, identification, and confirmation] using aquatic organism toxicity tests.)

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

WATER QUALITY-LIMITED SEGMENT: Any segment of a water body where it is known that water quality does not meet applicable water quality standards, and/or is not expected to meet applicable water quality standards, even after application of technology-based effluent limitations required by CLEAN WATER ACT sections 301(d) or 306.

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APPENDICIES