AMENDMENTS TO THE ~~ED~~ WATER QUALITY CONTROL PLAN FOR ENCLOSED BAYS AND ESTUARIES ~~PLAN~~ OF CALIFORNIA

~~Part 1:~~ Sediment Quality Provisions

[*The State Water Board intends in the future to create the Water Quality Control Plan for Inland Surface Waters, Enclosed Bays and Estuaries of California (ISWEBE). The State Water Board intends that the Sediment Quality provisions will be incorporated in the ISWEBE Plan, once it is created.*

The following text, except the italicized annotations, represents current language and proposed changes and additions to the Sediment Quality Provisions contained in the Water Quality Control Plan for Enclosed Bays and Estuaries of California (Enclosed Bays and Estuaries of California Plan), including format and organizational changes to accommodate future incorporation into the ISWEBE Plan. Proposed additions are indicated by underlined text and proposed deletions are indicated by strike-through text. Text that has been relocated but not otherwise changed is not shown in underline or strike-through. Relocations are noted in italicized annotations.

When the Sediment Quality Provisions contained in the Enclosed Bays and Estuaries Plan are incorporated into the ISWEBE Plan, some editorial revisions may be made, including but not limited to appropriate changes to the title page, table of contents, appendices, page numbers, table and figure numbers, footnote numbers, and headers and footers.]

May 7, 2018~~October 23, 2017~~~~April 6, 2011~~

Document format explanation: Red underline additions and red strikeout deletions represent initial changes circulated October 23, 2017. Blue double underline additions and blue double strikeout deletions represent changes since the close of the comment period, December 14, 2017.

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LIST OF TABLES

[The following revisions to Part 1, Sections I.A and I.B of the Enclosed Bays and Estuaries of California Plan are intended to be incorporated into Chapter I of the ISWEBE Plan. Only proposed additions and deletions are show in underline/strikethrough.]

I. INTRODUCTION

A. SEDIMENT

~~1. Intent and Summary~~

1. ~~A.~~ Intent of ~~Part 1~~ the Sediment Quality Provisions of the Water Quality Control Plan for Enclosed Bays and Estuaries of California ~~(Part 1)~~

It is the goal of the State Water Resources Control Board (State Water Board) to comply with the legislative directive in Water Code section 13393 to adopt sediment quality objectives (SQOs). ~~Part 1~~The Sediment Quality Provisions integrates chemical and biological measures to determine if the sediment-dependent biota are protected or degraded as a result of exposure to toxic pollutants* in sediment in order to protect benthic* communities in enclosed bays* and estuaries*, human health, wildlife, and resident finfish. ~~Part 1 is~~ The Sediment Quality Provisions are not intended to address low dissolved oxygen, pathogens or nutrients including ammonia. The State Water Board will continue to refine benthic community protection indicators for estuarine waters and improve the approach to address sediment quality related human health risk associated with consumption of fish tissue.

2. ~~B.~~ Summary of ~~Part 1~~the Sediment Quality Provisions

~~Part 1~~The Sediment Quality Provisions include~~s~~:

- ~~1.~~ Narrative SQO for the protection of aquatic life.
- ~~2.~~ Narrative SQO for the protection of human health.
- ~~3.~~ Narrative SQO for the protection of wildlife* and resident finfish*.
- ~~4.~~ Identification of the beneficial uses that these SQOs are intended to protect.
- ~~5.~~ A program of implementation for each SQO that contains:
  - ~~a.~~ Specific indicators, tools and implementation provisions to determine if the sediment quality at a station or multiple stations meets the narrative objectives;
  - ~~b.~~ A description of appropriate monitoring programs; and
  - ~~c.~~ A sequential series of actions that shall be initiated when a sediment quality objective is not met, including stressor identification and evaluation of appropriate targets.
- ~~6.~~ A glossary that defines all terms denoted by an asterisk.

[The following table is relocated from Part 1, Section III of the Enclosed Bays and Estuaries of California Plan. Only proposed additions to this table are shown in red and underlined text.]

II. ~~III.~~ BENEFICIAL USES

A. SEDIMENT

Beneficial uses of waters protected by ~~Part 1~~the Sediment Quality Provisions and corresponding target receptors are identified in Table 1.

Table 1. Beneficial Uses and Target Receptors

Beneficial Uses*	Target Receptors
Estuarine Habitat	Benthic Community/finfish/wildlife
Marine Habitat	Benthic Community/ finfish/wildlife
Commercial and Sport Fishing	Human Health
Aquaculture	Human Health
Shellfish Harvesting	Human Health
Tribal tradition and Culture	Human Health
Tribal Subsistence Fishing	Human Health
Subsistence Fishing	Human Health
Rare, Threatened, or Endangered Species	finfish/wildlife
Preservation of Biological Habitats of Special Significance	finfish/wildlife
Wildlife Habitat	Wildlife
Spawning Reproduction and Early Development	Finfish

*Only applicable to those waters where the beneficial use is assigned within a Basin Plan.

[The following additions and revisions to the Enclosed Bays and Estuaries of California Plan are intended to be incorporated into Chapter III (Water Quality Objectives) of the ISWEBE plan when it is adopted.]

III. WATER QUALITY OBJECTIVES

A. SEDIMENT

1. ~~II.~~ Use and Applicability of SQOS

a. ~~A.~~ Ambient Sediment Quality

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

b. ~~B.~~ Relationship to Other Narrative Objectives and Total Maximum Daily Loads

1) ~~1.~~ Except as provided in paragraph 3) below, ~~Part 1~~the Sediment Quality Provisions supersede~~s~~ all applicable narrative water quality objectives and related implementation provisions in water quality control plans (basin plans), to the extent that the objectives and provisions are applied to protect bay or estuarine benthic communities from toxic pollutants in sediments.

2) ~~2.~~ Except as provided in paragraph 3) below, ~~Part 1~~the Sediment Quality Provisions also supersede~~s~~ all applicable narrative water quality objectives and related implementation provisions in basin plans, to the extent that the objectives and provisions are applied to protect wildlife and resident finfish from toxic pollutants in sediments, unless the State Water Board approves amendments to a basin plan to incorporate new, more stringent, narrative water quality objectives or implementation provisions.

3) ~~3.~~ The supersession provisions in paragraphs 1) and 2) above do not apply to existing sediment cleanup activities where a site assessment was completed and submitted to the Regional Water Quality Control Board (Regional Water Board) by February 19, 2008.

4) Implementation provisions described in Chapter IV.A.2 and applicable provisions in Chapter IV.A.4 implementing the objective set forth in Chapter III.A.2.b. below do not apply to dischargers that discharge to receiving waters for which a total maximum daily load (TMDL) has been established, on or before the effective date of the Sediment Quality Provisions, to address ~~for~~ the bioaccumulation of organochlorine pesticide or polychlorinated biphenyls from sediment into sportfish tissue within enclosed bays and estuaries unless the applicable

Regional Water Board approves the application of such provisions.

c. ~~C.~~ Applicable Waters

~~Part 1~~the Sediment Quality Provisions appl~~ies~~y to enclosed bays[1] and estuaries[2] only. ~~Part 1 does~~The Sediment Quality Provisions do not apply to ocean waters* including Monterey Bay and Santa Monica Bay, or inland surface waters*.

d. ~~D.~~ Applicable Sediments

~~Part 1~~The Sediment Quality Provisions appl~~ies~~y to subtidal surficial sediments* that have been deposited or emplaced seaward of the intertidal zone. ~~Part 1 does~~ The Sediment Quality Provisions do not apply to:

1) ~~1.~~ Sediments characterized by less than five percent of fines (sum of percent silt and percent clay) or substrates composed of gravels, cobbles, or consolidated rock.

2) ~~2.~~ Sediment as the physical pollutant that causes adverse biological response or community degradation related to burial, deposition, or sedimentation.

e. ~~E.~~ Applicable Discharges

~~Part 1 is~~The Sediment Quality Provisions are applicable in ~~its~~ their entirety to point source* discharges. Nonpoint sources* of toxic pollutants are subject to ~~Sections II, III, IV, V, and VI~~ Chapters II.A, III.A, IV.A.1, IV.A.2., IV.A.3 of ~~Part 1~~The Sediment Quality Provisions.

2. ~~IV.~~ Sediment Quality Objectives

a. ~~A.~~ Aquatic Life* - Benthic Community Protection

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

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

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

b. ~~B.~~ Human Health

Pollutants shall not be present in sediments at levels that will bioaccumulate in aquatic life to levels that are harmful to human health in bays and estuaries of California. This narrative objective shall be implemented as described in Chapter IV.A.2.~~Section VI.A of Part 1~~.

c. ~~C.~~ Wild-life and Resident Finfish

Pollutants shall not be present in sediment at levels that alone or in combination are toxic to wildlife and resident finfish by direct exposure or bioaccumulate in aquatic life at levels that are harmful to wildlife or resident finfish by indirect exposure in bays and estuaries of California. This narrative objective shall be implemented as described in Chapter IV.A.3~~Section VI.B of Part 1~~.

[The following additions and revisions to the Enclosed Bays and Estuaries of California Plan are intended to be incorporated into Chapter IV (Implementation of Water Quality Objectives) of the ISWEBE Plan when it is adopted.]

IV. IMPLEMENTATION OF WATER QUALITY OBJECTIVES

A. SEDIMENT

1. ~~V.~~ Implementation for Assessing Benthic Community Protection

a. ~~A.~~ MLOE Approach to Interpret the Narrative Objective

The methods and procedures described below shall be used to interpret the Narrative Objective described in Chapter III.A.2.a~~Section IV.A~~. These tools are intended to assess the condition of benthic communities relative to potential for exposure to toxic pollutants in sediments. Exposure to toxic pollutants at harmful levels will result in some combination of a degraded benthic community, presence of toxicity, and elevated concentrations of pollutants in sediment. The assessment of sediment quality shall consist of the measurement and integration of three lines of evidence (LOE). The LOE are:

- ***Sediment Toxicity***—Sediment toxicity is a measure of the response of invertebrates exposed to surficial sediments under controlled laboratory conditions. The sediment toxicity LOE is used to assess both pollutant related biological effects and exposure. Sediment toxicity tests are of short durations and may not duplicate exposure conditions in natural systems. This LOE provides a measure of exposure to all pollutants present, including non-traditional or unmeasured chemicals.
- ***Benthic Community Condition***—Benthic community condition is a measure of the species composition, abundance and diversity of the sediment-dwelling invertebrates inhabiting surficial sediments*. The benthic community LOE is used to assess impacts to the primary receptors targeted for protection under Chapter III.A.2.a~~Section IV.A~~. Benthic community composition is a measure of the biological effects of both natural and anthropogenic stressors.
- ***Sediment Chemistry***—Sediment chemistry is the measurement of the concentration of chemicals of concern* in surficial sediments. The chemistry LOE is used to assess the potential risk to benthic organisms from toxic pollutants in surficial sediments. The sediment chemistry LOE is intended only to evaluate overall exposure risk from chemical pollutants. This LOE does not establish causality associated with specific chemicals.

b. ~~B.~~ Limitations

None of the individual LOE is sufficiently reliable when used alone to assess sediment quality impacts due to toxic pollutants. Within a given site, the LOEs applied to assess exposure as described in Chapter IV.A.1.a~~Section V.A~~ may underestimate or overestimate the risk to benthic communities and do not indicate causality of specific chemicals. The LOEs applied to assess biological effects can respond to stresses associated with natural or physical factors, such as sediment grain size, physical disturbance, or organic enrichment.

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

c. ~~C.~~ Water Bodies

1) ~~1.~~ The tools described in the Chapters IV.A.1.d through IV.A.1.i ~~Sections V.D. through V.I.~~ are applicable to Euhaline* Bays and Coastal Lagoons* south of Point Conception and Polyhaline* San Francisco Bay that includes the Central and South Bay Areas defined in general by waters south and west of the San Rafael Bridge and north of the Dumbarton Bridge.

2) ~~2.~~ For all other bays and estuaries where LOE measurement tools are unavailable, station assessment will follow the procedure described in Chapter IV.A.1.j~~Section V.J~~.

d. ~~D.~~ Field Procedures

1) ~~1.~~ All samples shall be collected using a grab sampler.

2) ~~2.~~ Benthic samples shall be screened through:

   a. A 0.5 millimeter (mm)-mesh screen in San Francisco Bay and the Sacramento-San Joaquin Delta.

   b. A 1.0 mm-mesh screen in all other locations.

3) ~~3.~~ Surface sediment from within the upper 5 cm shall be collected for chemistry and toxicity analysis.

4) ~~4.~~ The entire contents of the grab sample, with a minimum penetration depth of 5 cm, shall be collected for benthic community analysis.

5) ~~5.~~ Bulk sediment chemical analysis will include at a minimum the pollutants identified in Appendix A-3~~Attachment A~~.

e. ~~E.~~ Laboratory Testing

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

f. ~~F.~~ Sediment Toxicity

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

Table 2. Acceptable Short-Term Survival Sediment Toxicity Test Methods

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

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

Table 3. Acceptable Sublethal Sediment Toxicity Test Methods

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

3) ~~3.~~ Assessment of Sediment Toxicity—Each sediment toxicity test result shall be compared and categorized according to responses in Table 4. The response categories are:

a. Nontoxic—Response not substantially different from that expected in sediments that are uncontaminated and have optimum characteristics for the test species (e.g., control sediments).

b. Low toxicity—A response that is of relatively low magnitude; the response may not be greater than test variability.

c. Moderate toxicity—High confidence that a statistically significant toxic effect is present.

d. High toxicity—High confidence that a toxic effect is present and the magnitude of response includes the strongest effects observed for the test.

Table 4. Sediment Toxicity Categorization Values

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

* Expressed as a percentage of the control.

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

g. ~~G.~~ Benthic Community Condition

1) ~~1.~~ General Requirements.

a. All benthic invertebrates in the screened sample shall be identified to the lowest possible taxon and counted.

b. Taxonomic nomenclature shall follow current conventions established by local monitoring programs and professional organizations (e.g., master species list).

2) ~~2.~~ Benthic Indices—The benthic condition shall be assessed using the following methods:

a. Benthic Response Index (BRI), which was originally developed for the southern California mainland shelf and extended into California's bays and estuaries. The BRI is the abundance-weighted average pollution* tolerance score of organisms occurring in a sample.

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

c. Relative Benthic Index (RBI), which was developed for embayments in California's Bay Protection and Toxic Cleanup Program. The RBI is the weighted sum of: (a) several community parameters (total number of species, number of crustacean species, number of crustacean individuals, and number of mollusc species), and abundances of (b) three positive, and (c) two negative indicator species.

d. River Invertebrate Prediction and Classification System (RIVPACS), which was originally developed for British freshwater streams and adapted for California's bays and estuaries. The approach compares the assemblage at a site with an expected species composition determined by a multivariate predictive model that is based on species relationships to habitat gradients.

3) ~~3.~~ Assessment of Benthic Community Condition—Each benthic index result shall be categorized according to disturbance as described in Table 5. The disturbance categories are:

a. Reference—A community composition equivalent to a least affected or unaffected site.

b. Low disturbance— A community that shows some indication of stress, but could be within measurement error of unaffected condition.

c. Moderate disturbance—Confident that the community shows evidence of physical, chemical, natural, or anthropogenic stress.

d. High disturbance—The magnitude of stress is high.

4) ~~4.~~ Integration of Benthic Community Categories—The median of all benthic index response categories shall determine the benthic condition LOE category. If the median falls between categories it shall be rounded up to the next higher effect category.

Table 5. Benthic Index Categorization Values

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

h. ~~H.~~ Sediment Chemistry

1) 1. All samples shall be tested for the analytes identified in Appendix A-3~~Attachment A~~—This list represents the minimum analytes required to assess exposure. In water bodies where other toxic pollutants are believed to pose risk to benthic communities, those toxic pollutants shall be included in the analysis. Inclusion of additional analytes cannot be used in the exposure assessment described below. However, the data can be used to conduct more effective stressor identification studies as described in Chapter IV.A.4.f~~Section VII. F~~.

2) ~~2.~~ Sediment Chemistry Guidelines—The sediment chemistry exposure shall be assessed using the following two methods:

a. Chemical Score Index (CSI), that uses a series of empirical thresholds to predict the benthic community disturbance category (score) associated with the concentration of various chemicals (Table 6). The CSI is the weighted sum of the individual scores (Equation 1).

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

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

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

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

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

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

Chemical	Units	Weight	Score (Disturbance Category)			
			1 Reference	2 Low	3 Moderate	4 High
Copper	mg/kg	100	≤52.8	> 52.8 to 96.5	> 96.5 to 406	> 406
Lead	mg/kg	88	≤ 26.4	> 26.4 to 60.8	> 60.8 to 154	> 154
Mercury	mg/kg	30	≤ 0.09	> 0.09 to 0.45	> 0.45 to 2.18	> 2.18
Zinc	mg/kg	98	≤ 113~~2~~	> 113~~2~~ to 201~~0~~	> 201~~0~~ to 629	> 629
PAHs, total high MW	µg/kg	16	≤ 313~~2~~	> 313~~2~~ to 1325	> 1325 to 9320	>9320
PAHs, total low MW	µg/kg	5	≤ 85.4	> 85.4 to 312	> 312 to 2471	> 2471
Chlordane, alpha-	µg/kg	55	≤ 0.50	> 0.50 to 1.23	> 1.23 to 11.1	>11.1

Chlordane, gamma-	µg/kg	58	≤ 0.54	> 0.54 to 1.45	> 1.45 to 14.5	> 14.5
DDDs, total	µg/kg	45~~6~~	≤ 0.77~~50~~	> 0.77~~50~~ to 3.56~~2.69~~	> 3.56~~2.69~~ to 26.37~~117~~	> 26.37~~117~~
DDEs, total	µg/kg	33~~1~~	≤ 1.19~~0.50~~	>1.19~~0.50~~ to 6.01~~4.15~~	> 6.01~~4.15~~ to 45.84~~154~~	>45.84~~154~~
DDTs, total	µg/kg	20~~16~~	≤ 0.61~~50~~	> 0.61~~50~~ to 2.79~~1.52~~	> 2.79~~1.52~~ to 34.27~~89.3~~	> 34.27~~89.3~~
PCBs, total	µg/kg	55	≤11.9	> 11.9 to 24.7	> 24.7 to 288	> 288

Table 7. CA LRM Regression Parameters

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

3) ~~3.~~ Assessment of Sediment Chemistry Exposure—Each sediment chemistry guideline result shall be categorized according to exposure as described in Table 8. The exposure categories are:

a. Minimal exposure—Sediment-associated contamination* may be present, but exposure is unlikely to result in effects.

b. Low exposure—Small increase in pollutant exposure that may be associated with increased effects, but magnitude or frequency of occurrence of biological impacts is low.

c. Moderate exposure—Clear evidence of sediment pollutant exposure that is likely to result in biological effects; an intermediate category.

d. High exposure—Pollutant exposure highly likely to result in possibly severe biological effects; generally present in a small percentage of the samples.

Table 8. Sediment Chemistry Guideline Categorization Values

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

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

i. ~~I.~~ Interpretation and Integration of MLOE

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

1) ~~1.~~ Severity of Biological Effects—The severity of biological effects present at a site shall be determined by the integration of the toxicity LOE and benthic condition LOE categories using the decision matrix presented in Table 9.

2) ~~2.~~ Potential for Chemically-Mediated Effects—The potential for effects to be chemically-mediated shall be determined by the integration of the toxicity LOE and chemistry LOE categories using the decision matrix presented in Table 10.

Table 9. Severity of Biological Effects Matrix

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

Table 10. Potential for Chemically-Mediated Effects Matrix

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

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

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

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

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

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

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

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

Table 11. Station Assessment Matrix

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

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

The station assessment resulting from each possible combination of the three LOEs is shown in Appendix A-4~~Attachment B~~. As an alternative to Tables 9, 10 and 11, each LOE category can be applied to Appendix A-

4~~Attachment B~~ to determine the overall condition of the station. The results will be the same regardless of the tables used.

4) ~~4.~~ Relationship to the Aquatic Life – Benthic Community Protection Narrative Objective.

a. The categories designated as **Unimpacted** and **Likely Unimpacted** shall be considered as achieving the protective condition at the station. All other categories shall be considered as degraded except as provided in b. below.

b. The Water Board shall designate the category **Possibly Impacted** as meeting the protective condition if the studies identified in Chapter IV.A.4.f~~Section VII.F~~ demonstrate that the combination of effects and exposure measures are not responding to toxic pollutants in sediments and that other factors are causing these responses within a specific reach segment or waterbody. In this situation, the Water Board will consider only the Categories **Likely Impacted** and **Clearly Impacted** as degraded when making a determination on receiving water limits and impaired water bodies described in Chapter IV.A.4~~Section VII~~.

j. ~~J.~~ MLOE Approach to Interpret the Narrative Objective in Other Bays and Estuaries

Station assessments for waterbodies identified in Chapter IV.A.1.c.2~~Section V.C.2~~. will be conducted using the same conceptual approach and similar tools to those described in Chapters IV.A.1.d through IV.A.1.h~~Sections V.D-H~~. Each LOE will be evaluated by measuring a set of readily available indicators in accordance with Tables 12 and 13.

1) ~~1.~~ Station assessment shall be consistent with the following key principles of the assessment approach described in Chapters IV.A.1.d through IV.A.1.i~~Sections V.D. through V.I~~:

a. Results for a single LOE shall not be used as the basis for an assessment.

b. Evidence of both elevated chemical exposure and biological effects must be present to indicate pollutant-associated impacts.

c. The categorization of each LOE shall be based on numeric values or a statistical comparison.

2) ~~2.~~ Lines of Evidence and Measurement Tools—Sediment chemistry, toxicity, and benthic community condition shall be measured at each station. Table 12 lists the required tools for evaluation of each LOE. Each measurement shall be conducted using standardized methods (e.g., EPA or ASTM guidance) where available.

3) ~~3.~~ Categorization of LOEs—Determination of the presence of an LOE effect (i.e., biologically significant chemical exposure, toxicity, or benthic community disturbance) shall be based on

a comparison to a numeric response value or a statistical comparison to reference stations. The numeric values or statistical comparisons (e.g., confidence interval) used to classify a LOE as Effected shall be comparable to those specified in Chapters IV.A.1.f through IV.A.1.h~~Sections V.F-H.~~ to indicate High Chemical Exposure, High Toxicity, or High Disturbance. Reference stations shall be located in an area expected to be uninfluenced by the discharge or pollutants of concern in the assessment area and shall be representative of other habitat characteristics of the assessment area (e.g., salinity, grain size). Comparison to reference shall be accomplished by compiling data for appropriate regional reference sites and determining the reference envelope using statistical methods (e.g., tolerance interval).

Table 12. Tools for Use in Evaluation of LOEs

LOE	Tools	Metrics
Chemistry	Bulk sediment chemistry to include existing list (Appendix A-3.~~Attachment A~~) plus other chemicals of concern	CA LRM P_{max} Concentration on a dry weight basis
Sediment Toxicity	10-Day amphipod survival using a species tolerant of the sample salinity and grain size characteristics. e.g., *Hyalella azteca* or *Eohaustorius estuarius*	Percent of control survival
Benthic Community Condition	Invertebrate species identification and abundance	Species richness* Presence of sensitive indicator taxa Dominance by tolerant indicator taxa Presence of diverse functional and feeding groups Total abundance

Table 13. Numeric Values and Comparison Methods for LOE Categorization

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

4) ~~4.~~ Station Level Assessment—The station level assessment shall be determined using the decision matrix presented in Table 14. This assessment combines the classifications for each LOE to result in two categories of impact at the station level:

a. Unimpacted—No conclusive evidence of both high pollutant exposure and high biological effects present at the site. Evidence of chemical exposure and biological effects may be within natural variability or measurement error.

b. Impacted—Confident that sediment contamination present at the site is causing adverse direct impacts to aquatic life.

Table 14. Station Assessment Matrix for Other Bays and Estuaries

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

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

2. ~~VI.~~ Implementation for Assessing Human Health~~, WILDLIFE AND RESIDENT FINFISH PROTECTION~~

a. ~~A. Human Health~~ Approach to Interpret Objective for Contaminants Other than Chlorinated Pesticides and PCBs~~:~~

~~T~~the narrative human health objective in Chapter III.A.2.b~~Section IV.B. of this Part 1~~ shall be implemented on a case-by-case basis, based upon a human health risk assessment. In conducting a risk assessment, the Water Boards shall consider any applicable and relevant information, including California Environmental Protection Agency's (Cal~~/~~EPA) Office of Environmental Health Hazard Assessment (OEHHA) policies for fish consumption and risk assessment, Cal~~/~~EPA's Department of Toxic Substances Control (DTSC) Risk Assessment, and U.S. EPA Human Health Risk Assessment policies.

b. Approach to Interpret Objective for Chlorinated Pesticides and PCBs~~:~~

The methods and procedures described below shall be used to interpret the narrative objective described in Chapter III.A.2.b protecting human consumers of locally caught sportfish. These tools and associated assessment framework are intended to address the two components of the sediment quality objective protecting human consumers;

- Assess whether pollutant concentrations in sportfish pose unacceptable chemical exposure to human consumers and
- Assess whether sediment contamination at a site is a significant contributor to the sportfish contamination.

This framework relies on two indicators to address these components; **Chemical exposure indicator** compares sportfish contamination measurements from the site to consumption advisory thresholds. **Site Linkage indicator** compares sportfish contamination measurements to estimated sportfish concentrations that would result from site exposure. Integration of the results from both indicators produces a site assessment, which is a categorical description of the likelihood and magnitude of chemical exposure associated with sediment contamination within the site. The site assessment results are obtained using a categorical decision matrix to integrate the chemical exposure and site linkage indicators.

These indicators are applied within a tiered assessment framework. This assessment framework consists of three tiers:

Tier 1 is an optional screening assessment to address whether contaminants in sediments at a site pose a potential chemical exposure that warrants further evaluation. For contaminants in site sediments that pose such a potential, a Tier 2 evaluation is performed. Tier 1 requires fewer data relative to Tiers 2 and 3.

Tier 2 is a complete site assessment to assess sediment quality relative to the sediment quality objective protecting human consumers of locally caught sportfish. Tier 2 requires site specific information and data, including sediment and sportfish tissue chemistry, sediment organic carbon and percent lipid in tissue. The data are used to calculate average chemical exposure from consumption and the probability distribution of linkage between contaminants in sediment and sportfish.

Tier 3 is a more complex and site-specific assessment intended to supplement the Tier 2 evaluation. Greater flexibility is provided to address unique site conditions, confounding factors or other chemical exposure factors. Tier 3 may be employed only after ~~completion of Tier 2 and shall~~ meeting the conditions described in Chapter IV.A.2.e.2~~b.7~~).

1) Limitations

Each indicator is intended to provide specific information for use in the tiered assessment framework. This assessment framework applies only to specific nonpolar chlorinated hydrocarbons: total DDTs, total PCBs, total chlordanes and Dieldrin. The framework may be applied to assess either the entire water body or a portion, provided that the site area is at least 1 km^2. For small site areas, limitations on the allowable fish species apply as described in Appendix A-5.

2) Routine Monitoring

This assessment framework and tools are applicable to all enclosed bays and estuaries of California.

3) Field Procedures

All studies shall adhere to the following:

a.~~1.~~ All sediment samples shall be collected using a grab sampler.

b.~~2.~~ Surface sediment from within the upper 5 cm shall be collected for chemistry analyses.

c.~~3.~~ Water samples shall be collected using passive samplers, high volume filtration, or bulk collection.

d.~~4.~~ Fish tissue shall be collected from the species identified in Appendix A-6. Secondary species may only be used if primary species cannot be collected from the site.

e.~~a.~~ Fish shall be collected by any legal method of take.
f.~~b.~~ Fish shall meet sportfish angling size requirements, or if not possible, as close to the size requirement as practical.
g.~~c.~~ Fish shall be collected from within the site boundaries, or if not possible as close to the site as practical. Fish collected outside the waterbody of interest shall not be used in this assessment.
h.~~d.~~ Specific tissue types (e.g fillet or whole fish) required for each species are identified in Appendix A-6.
i.~~5.~~ Sediment and tissue chemical analysis shall include the constituents identified in Appendix A-7.

Before commencing with sample collection, a study design and workplan must be developed and approved by the Regional Board. Study design considerations are described in Appendix A-5. The conceptual site model shall serve as the basis for the study design, define the site boundaries, guide selection of sportfish species to evaluate, and identify appropriate sediment contamination data.

4) Laboratory Testing

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

Table 15 Laboratory Testing Requirements by Tier

Tier	Organochlorine Pest/PCBs in Sediment[3]	Total Organic Carbon	Organochlorine Pest/PCBs in Tissue[3]	Percent Lipid	Organochlorine Pest/PCBs in Water[3]
1	Yes[1]	Yes[1]	Yes[2]	No	No
2	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes

1. Necessary if using sediment data for the Tier 1 assessment.
2. Necessary if using tissue for the Tier 1 assessment.
3. Complete list of constituents is included in Appendix A-7

5) Tiered Assessment Framework

The assessment framework is intended for use in conjunction with high quality data representative of site specific conditions and factors. A conceptual site model (CSM) and study design as described in Chapter IV.A.4.d.5) must be developed prior to data analysis. Sediment and tissue data shall not be used to assess sediments in accordance with this plan, unless they are consistent with the CSM. A well-designed study is necessary to ensure that the relationship between the contaminants in site sediment and fish tissue is assessed appropriately and that conclusions can be made with confidence (see Chapter IV.A.4.d and Appendix A-5. for study design considerations).

c. Tier 1 Screening Evaluation

1) Purpose

Tier 1 is an optional screening evaluation that uses standardized conservative methods to evaluate the potential chemical exposure to human consumers of sportfish. The purpose of this tier is to determine whether site sediments pose a sufficient risk to warrant a complete (i.e., Tier 2) site assessment. If potential chemical exposure is below this level, sediments are ~~not degraded~~unimpacted and there is no reason to perform more detailed assessment (either Tier 2 or Tier 3). Tier 1 utilizes conservative assumptions to address uncertainty and reduce the chance of concluding unacceptable chemical exposure does not exist when in fact it does.

A Tier 1 assessment may be performed using either sportfish tissue contaminant concentrations or sediment contaminant concentrations and total organic carbon, depending on what data are available. If both sediment and tissue contamination data are available, the Tier 1~~I~~ assessment is performed using both data types.

2) Tier 1 Data Requirements

Tier 1 chemical exposure evaluation is obtained using all data that meet the following criteria:

a. Existing sediment and tissue data shall be no more than 6 years old at the time of the assessment and collected within site boundaries.
b. Sediment data must include matching total organic carbon content for site, or an estimate based on other data.
c. Sediment and tissue chemistry must include the constituents identified in Appendix A-7.
d. Only tissue from those primary or secondary species listed in Appendix A-6 shall be used in the analysis

3) Tissue Evaluation

The tissue-based chemical exposure evaluation is performed by comparing measured tissue concentration to screening thresholds. This comparison shall be based on tissue data from all the species identified in the CSM.

The Tier 1 tissue concentration (C_{Tis95}) is equal to the mean of the 95% upper confidence limit (UCL) of the mean tissue concentration for each species.

Equation 3 $C_{Tis95} = [\Sigma\, C_{Tis95}]/n$

Where

C_{Tis95i} = 95%UCL of the mean tissue concentration for sportfish species i (ng/g ww)

Σ is the sum across all species, and n is the number of species.

The minimum number of tissue samples required for Tier 1 assessment is 3. ~~Where the sample size is too low to calculate the UCL for a given species (less than 3), the maximum concentration is used for that species.~~

To assess chemical exposure, the Tier 1 tissue concentration shall be compared to the tissue screening thresholds in Table 16. If the tissue concentration is greater than any tissue screening threshold in Table 16, there is the potential for unacceptable chemical exposure and a Tier 2 evaluation is required. If the tissue concentration is equal to or less than the tissue screening threshold, the chemical exposure is acceptable. Tier 1 assessment of subsistence fishers may be accomplished by applying thresholds based on Office of Environmental Health Hazard Assessment (OEHHA) Advisory Tissue Levels based on 5 day consumption rate in lieu of those provided in Table 16. Use of subsistence thresholds shall only be applied to those waters where the Tribal Beneficial Uses or Tribal Subsistence Beneficial Uses have been designated by the applicable Regional Water Board.

Table 16. Tier 1 tissue screening thresholds

Parameter	Total DDTs (ng/g ww)	Total PCBs (ng/g ww)	Total Chlordanes (ng/g ww)	Dieldrin (ng/g ww)
Tier 1 Threshold[a]	>520	>21	>190	>15

[a] Advisory Tissue Level based on three servings per week (OEHHA 2008).

4) Sediment Evaluation

Tier 1 sediment evaluation is also based on chemical exposure. The Tier 1 Sediment Evaluation is performed by comparing site sediment concentration to sediment screening thresholds. Sediment screening thresholds are calculated for each contaminant evaluated at the site. To conduct the sediment evaluation, compare the 95% UCL of the mean concentration for site sediment to the threshold. The minimum number of sediment samples required for Tier 1 assessment is 3. ~~Where the sample size is too low to calculate the UCL, the maximum sediment contaminant concentration is used for the site as the sediment linkage estimate.~~

The sediment threshold is calculated as the tissue threshold divided by a biota-sediment accumulation factor (BSAF):

Equation 4 $T_{Sed} = (T_{Tis})/(BSAF)$

Where

T_{Sed} = sediment screening threshold (ng/g dw)

T_{Tis} = tissue screening threshold in nanograms per gram wet weight (ng/g ww)

BSAF = biota-sediment accumulation factor (BSAF) defined as wet weight chemical concentration in biota divided by dry weight chemical concentration in sediment

The highest BSAF for the dietary guilds identified in the CSM shall be used in calculating the sediment screening threshold. Tissue screening thresholds are provided in Table 16. The biota-sediment accumulation factors (BSAFs) based on the contaminant, fish guild, and site total organic carbon are included in Table 17.

5) Tier 1 Interpretation

The Tier 1 screening evaluation is only applied to assess whether sediment is unimpacted in relation to the sediment quality objective or if a more detailed analysis is required by conducting a Tier 2 assessment. Possible outcomes of the Tier 1 screening are described below.

If ~~either~~only tissue or only sediment is applied in Tier 1 and the result exceeds the threshold for any constituent, Tier 2 is required for those constituents. If both tissue and sediment are applied the possible outcomes are as follows:

a. If both tissue and sediment results fall~~s~~ below the threshold, ~~the chemical exposure associated with the sediment and tissue is acceptable and~~ the sediment quality is ~~**not**~~ **unimpacted**.
b. If tissue results fall below the threshold and sediment equals or exceeds the threshold, ~~the chemical~~

~~exposure is acceptable and~~ the sediment quality is ~~**not**~~ **unimpacted.**

c. If sediment results fall below the threshold and tissue equals or exceeds the threshold, ~~the chemical exposure to consumers is unacceptable and~~ a Tier 2 **assessment is required** for those constituents above Tier 1 thresholds.

d. If both sediment and tissue results equal or exceed the threshold, ~~the chemical exposure to consumers is unacceptable and~~ a Tier 2 **assessment is required** for those constituents above Tier 1 thresholds.

Table 17. Tier 1 Biota sediment accumulation factors (BSAF) calculated for percent total organic carbon

TOC (%)	1. Piscivore				2a. Benthic with piscivory				2b. Benthic with piscivory (White catfish only)			
	Chlor	DDTs	Diel	PCBs	Chlor	DDTs	Diel	PCBs	Chlor	DDTs	Diel	PCBs
0.1	65.8	83.1	28.1	79.0	68.6	90.8	28.5	86.8	86.6	118.3	34.1	113.6
0.2	33.7	43.6	14.2	41.8	35.7	48.5	14.5	46.9	44.9	63.2	17.3	61.4
0.3	23.0	30.4	9.5	29.4	24.7	34.4	9.8	33.6	31.0	44.8	11.6	43.9
0.4	17.6	23.7	7.2	23.1	19.2	27.3	7.5	26.8	24.0	35.5	8.8	35.1
0.6	12.2	17.0	4.8	16.8	13.7	20.1	5.2	20.0	17.0	26.1	6.0	26.1
0.8	9.5	13.6	3.7	13.5	10.9	16.4	4.0	16.5	13.5	21.3	4.6	21.5
1.0	7.9	11.5	3.0	11.6	9.3	14.2	3.3	14.3	11.4	18.4	3.8	18.6
1.2	6.8	10.1	2.5	10.2	8.1	12.7	2.8	12.9	9.9	16.3	3.2	16.7
1.4	6.0	9.1	2.2	9.2	7.3	11.5	2.5	11.8	8.9	14.8	2.8	15.2
1.6	5.4	8.3	1.9	8.4	6.7	10.7	2.2	10.9	8.1	13.7	2.5	14.1
1.8	5.0	7.7	1.7	7.8	6.2	10.0	2.0	10.2	7.5	12.8	2.3	13.2
2.0	4.6	7.2	1.6	7.3	5.8	9.4	1.9	9.7	7.0	12.0	2.1	12.4
2.5	3.9	6.2	1.3	6.4	5.1	8.3	1.6	8.6	6.1	10.6	1.7	11.0
3.0	3.4	5.6	1.1	5.7	4.6	7.5	1.4	7.8	5.5	9.6	1.5	10.0
3.5	3.1	5.1	1.0	5.2	4.2	7.0	1.3	7.2	5.0	8.8	1.3	9.2
4.0	2.8	4.7	0.9	4.8	3.9	6.5	1.2	6.7	4.6	8.2	1.2	8.6

Chlor – Total Chlordanes; Diel – Dieldrin; DDTs – Total DDTs; PCBs – Total PCBs

	~~1. Piscivore (California Halibut)~~				~~2. Benthic with piscivory (Spotted Sand Bass)~~				~~3.Benthic and pelagic with piscivory (Queenfish)~~				~~4. Benthic without piscivory (White Croaker)~~			
~~TOC (%)~~	~~Chlor~~	~~DDTs~~	~~Diel~~	~~PCBs~~	~~Chlor~~	~~Chlor~~	~~DDTs~~	~~Diel~~	~~PCBs~~	~~DDTs~~	~~Chlor~~	~~DDTs~~	~~Diel~~	~~PCBs~~	~~Diel~~	~~Chlor~~
~~0.1~~	~~47.8~~	~~57.5~~	~~23.2~~	~~54.6~~	~~53.5~~	~~67.7~~	~~24.8~~	~~64.7~~	~~68.9~~	~~81.5~~	~~32.6~~	~~76.6~~	~~62.3~~	~~72.9~~	~~39.1~~	~~70.1~~
~~0.2~~	~~24.5~~	~~30.2~~	~~11.6~~	~~29.0~~	~~27.9~~	~~36.3~~	~~12.6~~	~~35.0~~	~~34.9~~	~~41.9~~	~~16.4~~	~~39.6~~	~~32.9~~	~~40.3~~	~~20.0~~	~~39.4~~
~~0.3~~	~~16.7~~	~~21.0~~	~~7.8~~	~~20.4~~	~~19.3~~	~~25.7~~	~~8.6~~	~~25.1~~	~~23.6~~	~~28.6~~	~~11.0~~	~~27.2~~	~~23.1~~	~~29.4~~	~~13.6~~	~~29.1~~
~~0.4~~	~~12.8~~	~~16.4~~	~~5.9~~	~~16.0~~	~~15.0~~	~~20.4~~	~~6.5~~	~~20.1~~	~~17.9~~	~~22.0~~	~~8.3~~	~~21.0~~	~~18.2~~	~~23.8~~	~~10.4~~	~~23.8~~
~~0.6~~	~~8.9~~	~~11.8~~	~~4.0~~	~~11.6~~	~~10.7~~	~~15.1~~	~~4.5~~	~~15.0~~	~~12.3~~	~~15.4~~	~~5.5~~	~~14.8~~	~~13.2~~	~~18.1~~	~~7.2~~	~~18.4~~
~~0.8~~	~~6.9~~	~~9.5~~	~~3.0~~	~~9.4~~	~~8.6~~	~~12.4~~	~~3.5~~	~~12.4~~	~~9.4~~	~~12.0~~	~~4.2~~	~~11.7~~	~~10.7~~	~~15.2~~	~~5.6~~	~~15.5~~
~~1.0~~	~~5.7~~	~~8.0~~	~~2.4~~	~~8.0~~	~~7.3~~	~~10.7~~	~~2.9~~	~~10.8~~	~~7.7~~	~~10.0~~	~~3.4~~	~~9.8~~	~~9.2~~	~~13.3~~	~~4.6~~	~~13.7~~
~~1.2~~	~~4.9~~	~~7.0~~	~~2.1~~	~~7.1~~	~~6.4~~	~~9.5~~	~~2.5~~	~~9.7~~	~~6.6~~	~~8.7~~	~~2.8~~	~~8.5~~	~~8.1~~	~~12.0~~	~~4.0~~	~~12.5~~
~~1.4~~	~~4.4~~	~~6.3~~	~~1.8~~	~~6.4~~	~~5.7~~	~~8.7~~	~~2.2~~	~~8.9~~	~~5.8~~	~~7.7~~	~~2.5~~	~~7.6~~	~~7.4~~	~~11.1~~	~~3.5~~	~~11.5~~
~~1.6~~	~~3.9~~	~~5.8~~	~~1.6~~	~~5.9~~	~~5.3~~	~~8.0~~	~~1.9~~	~~8.2~~	~~5.1~~	~~7.0~~	~~2.2~~	~~6.9~~	~~6.8~~	~~10.3~~	~~3.2~~	~~10.7~~
~~1.8~~	~~3.6~~	~~5.4~~	~~1.4~~	~~5.5~~	~~4.9~~	~~7.5~~	~~1.8~~	~~7.7~~	~~4.7~~	~~6.4~~	~~1.9~~	~~6.3~~	~~6.4~~	~~9.7~~	~~2.9~~	~~10.1~~
~~2.0~~	~~3.3~~	~~5.0~~	~~1.3~~	~~5.1~~	~~4.6~~	~~7.1~~	~~1.6~~	~~7.3~~	~~4.3~~	~~5.9~~	~~1.8~~	~~5.9~~	~~6.0~~	~~9.2~~	~~2.7~~	~~9.6~~
~~2.5~~	~~2.8~~	~~4.3~~	~~1.1~~	~~4.5~~	~~4.0~~	~~6.3~~	~~1.4~~	~~6.5~~	~~3.6~~	~~5.1~~	~~1.4~~	~~5.1~~	~~5.3~~	~~8.2~~	~~2.3~~	~~8.5~~
~~3.0~~	~~2.5~~	~~3.9~~	~~0.9~~	~~4.0~~	~~3.6~~	~~5.7~~	~~1.2~~	~~5.9~~	~~3.1~~	~~4.5~~	~~1.2~~	~~4.5~~	~~4.8~~	~~7.4~~	~~2.0~~	~~7.8~~
~~3.5~~	~~2.2~~	~~3.5~~	~~0.8~~	~~3.6~~	~~3.3~~	~~5.3~~	~~1.1~~	~~5.5~~	~~2.8~~	~~4.1~~	~~1.1~~	~~4.1~~	~~4.4~~	~~6.8~~	~~1.8~~	~~7.2~~
~~4.0~~	~~2.1~~	~~3.3~~	~~0.7~~	~~3.4~~	~~3.1~~	~~4.9~~	~~1.0~~	~~5.1~~	~~2.5~~	~~3.7~~	~~0.9~~	~~3.8~~	~~4.1~~	~~6.4~~	~~1.7~~	~~6.7~~

Table 17. Tier 1 Biota sediment accumulation factors (BSAF) calculated for percent total organic carbon continued

TOC (%)	3.Benthic and pelagic with piscivory				4. Benthic without piscivory				5. Benthic and pelagic without piscivory			
	Chlor	DDTs	Diel	PCBs	Chlor	DDTs	Diel	PCBs	Chlor	DDTs	Diel	PCBs
0.1	89.0	110.6	37.2	103.9	71.7	85.6	42.7	82.4	27.6	32.9	15.9	31.6
0.2	45.1	56.7	18.7	53.6	37.9	47.3	21.8	46.2	14.3	17.6	8.0	17.2
0.3	30.4	38.7	12.5	36.8	26.6	34.4	14.8	34.0	9.9	12.5	5.4	12.3
0.4	23.1	29.7	9.4	28.3	20.9	27.9	11.3	27.9	7.6	9.9	4.1	9.8
0.6	15.8	20.7	6.3	19.9	15.2	21.2	7.8	21.5	5.4	7.3	2.8	7.3
0.8	12.1	16.2	4.8	15.6	12.3	17.7	6.1	18.1	4.3	6.0	2.2	6.1
1.0	9.9	13.5	3.9	13.1	10.6	15.6	5.0	16.0	3.6	5.1	1.8	5.3
1.2	8.5	11.6	3.2	11.4	9.4	14.1	4.3	14.5	3.2	4.6	1.5	4.7
1.4	7.4	10.3	2.8	10.1	8.5	12.9	3.8	13.4	2.8	4.2	1.3	4.3
1.6	6.6	9.3	2.5	9.2	7.8	12.0	3.5	12.5	2.6	3.8	1.2	4.0
1.8	6.0	8.5	2.2	8.4	7.3	11.3	3.2	11.8	2.4	3.6	1.1	3.7
2.0	5.5	7.9	2.0	7.8	6.9	10.7	2.9	11.2	2.2	3.4	1.0	3.5
2.5	4.6	6.8	1.6	6.7	6.1	9.5	2.5	9.9	1.9	3.0	0.8	3.1
3.0	4.0	6.0	1.4	6.0	5.5	8.7	2.2	9.1	1.7	2.7	0.7	2.8
3.5	3.6	5.4	1.2	5.5	5.1	8.0	2.0	8.3	1.6	2.5	0.6	2.6
4.0	3.2	5.0	1.1	5.0	4.7	7.4	1.8	7.8	1.5	2.3	0.6	2.4

Chlor – Total Chlordanes; Diel – Dieldrin; DDTs – Total DDTs; PCBs – Total PCBs

	~~5. Benthic and pelagic without piscivory (Shiner perch)~~				~~6 Benthic with herbivory (Common Carp)~~				~~7. Benthic and pelagic with herbivory (Topsmelt)~~				~~8. Pelagic with benthic herbivory (Striped Mullet)~~			
~~TOC (%)~~	~~Chlor~~	~~DDTs~~	~~Diel~~	~~PCBs~~	~~Chlor~~	~~DDTs~~	~~Diel~~	~~PCBs~~	~~Chlor~~	~~DDTs~~	~~Diel~~	~~PCBs~~	~~Chlor~~	~~DDTs~~	~~Diel~~	~~PCBs~~
~~0.1~~	~~23.8~~	~~27.5~~	~~14.7~~	~~26.4~~	~~52.6~~	~~52.8~~	~~38.9~~	~~49.0~~	~~17.8~~	~~18.5~~	~~12.8~~	~~17.4~~	~~38.1~~	~~31.3~~	~~36.4~~	~~28.3~~
~~0.2~~	~~12.3~~	~~14.7~~	~~7.4~~	~~14.3~~	~~27.6~~	~~28.3~~	~~20.2~~	~~26.5~~	~~9.1~~	~~9.6~~	~~6.5~~	~~9.1~~	~~20.0~~	~~16.7~~	~~18.9~~	~~15.3~~
~~0.3~~	~~8.5~~	~~10.4~~	~~5.0~~	~~10.3~~	~~19.3~~	~~20.1~~	~~13.9~~	~~18.9~~	~~6.2~~	~~6.6~~	~~4.3~~	~~6.3~~	~~13.9~~	~~11.9~~	~~13.0~~	~~10.9~~
~~0.4~~	~~6.6~~	~~8.3~~	~~3.8~~	~~8.2~~	~~15.1~~	~~15.9~~	~~10.8~~	~~15.2~~	~~4.7~~	~~5.1~~	~~3.3~~	~~4.9~~	~~10.9~~	~~9.4~~	~~10.1~~	~~8.7~~
~~0.6~~	~~4.7~~	~~6.1~~	~~2.6~~	~~6.1~~	~~10.9~~	~~11.8~~	~~7.7~~	~~11.3~~	~~3.3~~	~~3.6~~	~~2.2~~	~~3.5~~	~~7.9~~	~~7.0~~	~~7.2~~	~~6.5~~
~~0.8~~	~~3.7~~	~~5.0~~	~~2.0~~	~~5.1~~	~~8.8~~	~~9.6~~	~~6.1~~	~~9.3~~	~~2.5~~	~~2.9~~	~~1.7~~	~~2.8~~	~~6.4~~	~~5.7~~	~~5.7~~	~~5.4~~
~~1.0~~	~~3.1~~	~~4.3~~	~~1.6~~	~~4.4~~	~~7.5~~	~~8.3~~	~~5.2~~	~~8.1~~	~~2.1~~	~~2.4~~	~~1.4~~	~~2.4~~	~~5.4~~	~~5.0~~	~~4.8~~	~~4.7~~
~~1.2~~	~~2.7~~	~~3.8~~	~~1.4~~	~~3.9~~	~~6.6~~	~~7.4~~	~~4.5~~	~~7.3~~	~~1.8~~	~~2.1~~	~~1.2~~	~~2.1~~	~~4.8~~	~~4.5~~	~~4.2~~	~~4.3~~
~~1.4~~	~~2.4~~	~~3.5~~	~~1.2~~	~~3.6~~	~~6.0~~	~~6.8~~	~~4.1~~	~~6.7~~	~~1.6~~	~~1.9~~	~~1.0~~	~~1.9~~	~~4.4~~	~~4.1~~	~~3.8~~	~~3.9~~
~~1.6~~	~~2.2~~	~~3.2~~	~~1.1~~	~~3.3~~	~~5.5~~	~~6.3~~	~~3.7~~	~~6.2~~	~~1.4~~	~~1.7~~	~~0.9~~	~~1.7~~	~~4.0~~	~~3.8~~	~~3.5~~	~~3.7~~
~~1.8~~	~~2.1~~	~~3.0~~	~~1.0~~	~~3.1~~	~~5.1~~	~~5.8~~	~~3.4~~	~~5.8~~	~~1.3~~	~~1.6~~	~~0.8~~	~~1.6~~	~~3.7~~	~~3.6~~	~~3.2~~	~~3.5~~
~~2.0~~	~~1.9~~	~~2.8~~	~~0.9~~	~~2.9~~	~~4.8~~	~~5.5~~	~~3.2~~	~~5.5~~	~~1.2~~	~~1.5~~	~~0.7~~	~~1.5~~	~~3.5~~	~~3.4~~	~~3.0~~	~~3.3~~
~~2.5~~	~~1.7~~	~~2.5~~	~~0.8~~	~~2.6~~	~~4.2~~	~~4.9~~	~~2.8~~	~~4.8~~	~~1.0~~	~~1.3~~	~~0.6~~	~~1.3~~	~~3.1~~	~~3.1~~	~~2.6~~	~~3.0~~
~~3.0~~	~~1.5~~	~~2.2~~	~~0.7~~	~~2.4~~	~~3.8~~	~~4.4~~	~~2.5~~	~~4.4~~	~~0.9~~	~~1.2~~	~~0.5~~	~~1.2~~	~~2.8~~	~~2.8~~	~~2.4~~	~~2.7~~
~~3.5~~	~~1.4~~	~~2.1~~	~~0.6~~	~~2.2~~	~~3.4~~	~~4.0~~	~~2.3~~	~~4.0~~	~~0.8~~	~~1.1~~	~~0.5~~	~~1.1~~	~~2.6~~	~~2.6~~	~~2.2~~	~~2.6~~
~~4.0~~	~~1.3~~	~~1.9~~	~~0.5~~	~~2.0~~	~~3.2~~	~~3.7~~	~~2.2~~	~~3.8~~	~~0.8~~	~~1.0~~	~~0.4~~	~~1.0~~	~~2.4~~	~~2.5~~	~~2.0~~	~~2.4~~

Table 17. Tier 1 Biota sediment accumulation factors (BSAF) calculated for percent total organic carbon continued

	6 Benthic with herbivory				7. Benthic and pelagic with herbivory				8. Pelagic with benthic herbivory			
TOC (%)	Chlor	DDTs	Diel	PCBs	Chlor	DDTs	Diel	PCBs	Chlor	DDTs	Diel	PCBs
0.1	62.0	63.7	43.3	59.2	20.7	22.3	14.0	21.0	44.3	36.9	40.7	33.4
0.2	32.6	34.1	22.5	32.0	10.6	11.6	7.0	11.0	23.3	19.7	21.1	18.0
0.3	22.7	24.2	15.6	22.9	7.2	8.0	4.7	7.6	16.3	14.0	14.6	12.9
0.4	17.8	19.2	12.1	18.3	5.5	6.2	3.6	5.9	12.7	11.1	11.3	10.3
0.6	12.8	14.2	8.6	13.6	3.8	4.4	2.4	4.2	9.2	8.2	8.1	7.7
0.8	10.3	11.6	6.8	11.2	2.9	3.5	1.8	3.4	7.4	6.8	6.4	6.4
1.0	8.8	10.0	5.8	9.8	2.4	2.9	1.5	2.9	6.3	5.9	5.4	5.6
1.2	7.8	8.9	5.1	8.8	2.1	2.6	1.3	2.5	5.6	5.3	4.8	5.0
1.4	7.0	8.2	4.6	8.0	1.8	2.3	1.1	2.3	5.1	4.8	4.3	4.6
1.6	6.5	7.5	4.2	7.4	1.7	2.1	1.0	2.1	4.7	4.5	3.9	4.3
1.8	6.0	7.0	3.9	7.0	1.5	1.9	0.9	1.9	4.4	4.2	3.6	4.1
2.0	5.6	6.6	3.6	6.6	1.4	1.8	0.8	1.8	4.1	4.0	3.4	3.9
2.5	4.9	5.9	3.2	5.8	1.2	1.6	0.7	1.6	3.7	3.6	3.0	3.5
3.0	4.5	5.3	2.9	5.3	1.1	1.4	0.6	1.4	3.3	3.3	2.7	3.3
3.5	4.1	4.9	2.6	4.9	1.0	1.3	0.5	1.3	3.1	3.1	2.5	3.0
4.0	3.8	4.5	2.5	4.5	0.9	1.2	0.5	1.2	2.9	2.9	2.3	2.9

Chlor – Total Chlordanes; Diel – Dieldrin; DDTs – Total DDTs; PCBs – Total PCBs

d. Tier 2 Assessment

1) Purpose

The purpose of the Tier 2 assessment is to determine if site sediments meet the sediment quality objective described in Chapter III.A.2.b that protects human consumers of resident sportfish from bioaccumulative contaminants in sediment. Tier 2 is based on an evaluation of tissue data and sediment data to assess both chemical exposure to human consumers and the link to contaminants in sediment associated with the site. Chemical exposure is evaluated based on comparison to thresholds established by OEHHA. Evaluation of sediment linkage utilizes a mechanistic food web model to estimate tissue concentrations derived from measured sediment concentrations.

2) Tier 2 Data and Computational Requirements

Tier 2 utilizes a combination of site specific variables presented in Table 18 and fixed model input parameters. Both types are needed to complete the assessment

Table 18 Tier 2~~II~~ Site Specific Information.

Category	Variable	Quantity
Required	Tissue contaminant concentrations	Minimum of 3 samples per species preferably composites; minimum of two species, each representing a different dietary guild, included in assessment
Required	Tissue lipid content (%)	One from each tissue composite analyzed above
Required	Sediment contaminant concentrations	Minimum of 5 samples per site
Required	Sediment total organic carbon	One from each sediment sample analyzed
Required	Site Area and Length	One measurement
Required	Water Column Contaminant Concentrations	Site average or one estimate for site (min)
Optional	Total Suspended Sediment Concentration, Organic Carbon Concentration of Suspended Sediment, Dissolved Oxygen Concentration, Dissolved Organic Carbon Concentration	Site average or one estimate for site (min)
Optional	Temperature	Site average or one estimate for site
Optional	Salinity	Site average or one estimate for site

Values for optional variables may be based on site measurements (average), or estimated values based on a model (water column concentration) or regional monitoring data.

The fixed or constrained model parameters consist of the following:

- Proportion of sportfish species consumed
- Sportfish Characteristics

    - Diet
    - Home Range
- Contaminant Characteristics
    - Octanol water partitioning coefficient
- The bioaccumulation model constants listed in Appendix A-8

None of the parameters listed above may be changed in the Tier 2 assessment.

Tier 2 chemical exposure evaluation is obtained using all data that meets the following criteria:

a. Consistent with CSM as described in Chapter IV.A.4.d. and Appendix A-5

b. Sediment and tissue chemistry must include the appropriate constituents identified in Appendix A-7.

c. Tissue obtained from among the primary species ~~for each~~representing the dietary guilds, which ~~shall be used in the analysis. Primary species~~ are:

1. California halibut
2a. Spotted sand bass
~~3~~2b. White catfish
~~4~~3. Queenfish
~~5~~4. White croaker
~~6~~5. Shiner perch
~~7~~6. Common carp
~~8~~7. Topsmelt
~~9~~8. Striped mullet

Secondary species shall only be used as surrogate if the primary species cannot be obtained from the site. Tier 2 model calculations shall be based on primary species parameters when tissue from a secondary species is used. Weighting of species shall be based on equal proportions of each species unless justification for other proportion is provided based upon state angling surveys conducted by the California Department of Fish and Wildlife. Primary and secondary species and dietary guilds are presented in Appendix A-6.

3) Chemical Exposure Evaluation

Chemical exposure is assessed by comparing average tissue contaminant concentration to thresholds. The tissue thresholds are based on serving of one, two and three 8-ounce servings over the course of a week. Tissue thresholds are presented in Table 19, tissue categories and outcomes are presented in Table 20.

Table 19. Tier 2 Tissue contaminant thresholds

	Tier 2 Contaminant Threshold			
Parameter	FCG[1] (ng/g ww)	ATL3[2] (ng/g ww)	ATL2[3] (ng/g ww)	ATL1[4] (ng/g ww)
Total Chlordanes	5.6	190	280	560
Total DDTs	21	520	1,000	2100
Dieldrin	0.46	15	23	46

Total PCBs	3.6	21	42	120

1. FCG - Fish Contaminant Goal based on 1 meal per week
2. ATL3 - Tissue Advisory Level based on consumption of 3 meals per week
3. ATL2 - Tissue Advisory Level based on 2 meals per week
4. ATL1 - Tissue Advisory Level based on 1 meal per week

Table 20. Tier 2 Chemical Exposure categories

Tissue Contaminant Concentration	Threshold	Outcome
Average	≤ FCG	1. Very Low
Average	≤ ATL3	2. Low
Average	≤ ATL2	3. Moderate
Average	≤ ATL1	4. High
Average	> ATL1	5. Very High

4) Site Linkage Determination

A site linkage factor is calculated by comparing tissue concentrations estimated from site sediments to the observed tissue contaminant concentration for the same species used in the chemical exposure evaluation. Site linkage determination is performed separately for each contaminant class. A Monte Carlo simulation is used to generate a cumulative distribution of the site linkage factor. Percentiles are then compared to thresholds presented in Table 21 to categorize the Site Linkage for the site. The ratio of the sportfish tissue estimated due to sediment contamination at the site compared to the observed contamination in sportfish tissue serves as the basis for this determination as described in the following equation.

Equation 5~~7~~ C_{Est}/C_{Tis} = Site Linkage Factor

Where

C_{Est} = Weighted average estimated tissue contaminant concentration based on the proportion of the human diet for each guild (ng/g).

C_{Tis} = Weighted average observed tissue ~~contaminant~~ concentration

Estimated tissue concentrations are calculated from measured sediment contaminant concentrations based on the following equation.

Equation 6~~8~~ $C_{Est\,i} = \Sigma\, C_{Sed} \times BSAF_i \times SUF\cancel{A / HR}_i$.

Where:

$C_{Est\,i}$ = estimated tissue contaminant concentration in species i contributed from site sediments

$\Sigma\, C_{Sed}$ = measured average sum contaminant concentration (sum PCBs, sum DDTs, sum chlordanes, or dieldrin) in sediment from the site, spatially weighted if appropriate.

$BSAF_i$ = biota-sediment accumulation factor for species i

SUF_i = site use factor for species i = SA/HR_i

SA = site area (km^2) or length across the site (km)

HR_i = sportfish home range (km^2) or linear movement distance (km) for species i

If significant contaminant heterogeneity or gradients are suspected in site sediments, area weighted averaging may be used to provide a representative mean.

5) Calculation of BSAF

Tier 2 employs the Arnot and Gobas food web model (2004), modified by Gobas and Arnot (2010), to calculate the BSAF for each of the fish guild species. The Arnot and Gobas model is structured to depict contaminant concentration in biota as the mass balance of key uptake and loss processes as described in the following equation:

Equation 7~~9~~ Biota contaminant concentration = [(Respiratory Uptake x Water Concentration) + (Dietary Uptake x Prey Concentration)] / (Elimination + Fecal Egestion + Growth + Metabolism)

Where water concentration includes freely dissolved porewater and dissolved surface water concentrations, the proportions of which are dependent on the specific environment of each organism in the food web.

The dietary uptake for an organism is represented as:

Equation 8~~10~~ $k_D*\Sigma(P_i*C_{D,i})$

Where:

k_D = dietary uptake rate constant

P_i = proportion by mass of prey item *i* in the total diet

$C_{D,I}$ = contaminant concentration in prey item *i*

The Arnot and Gobas model, like other food web models, includes numeric inputs that are site specific and additional parameters that are constants. Site specific model inputs (e.g., sportfish lipid content, sediment organic carbon, and water quality parameters), are obtained locally and modified in each unique application of the model. Site specific inputs and food web model constants are tabulated in Appendix A-8. The model structure is specific to each fish species reflecting dietary and food web positions.

A biota contaminant concentration is calculated for each component of the food web. A BSAF is obtained for each sportfish species based on the following equation

Equation 9~~11~~ BSAF = biota contaminant concentration (wet weight)/ Sediment contaminant concentration (dry weight)

BSAF is the ratio of the wet weight contaminant concentration in biota to the average dry weight contaminant concentration in sediment. BSAF is calculated separately for each guild.

6) Calculation of Site ~~Sediment~~ Linkage Distribution

Monte Carlo simulation is used to calculate the distribution of the site ~~sediment~~ linkage factor based on variability or uncertainty in average measured sediment concentration data, average measured fish tissue concentration data, average fish home range and the estimated BSAF values~~calculation~~. Variability and uncertainty in the sediment and fish tissue concentration data is represented by the standard error of the average. Uncertainty in the estimated BSAF ~~calculation~~ is based on literature values.

The Monte Carlo simulation is conducted using 10,000 random subsamples of the concentration and BSAF distributions on a log normal basis. Site ~~sediment~~ linkage is calculated for each set of subsamples. See Appendix A-8 for additional details of the calculation.

7) Site~~Sediment~~ Linkage Evaluation

The results of the simulations are compiled to calculate a cumulative probability distribution of sediment linkage. The portion of the distribution less than the sediment linkage threshold is used to determine the site linkage category.

Table 21. Site ~~Sediment~~ Linkage Categories for Tier 2 Evaluation

Cumulative % of sediment linkage distribution above theshold	Linkage threshold	Outcome
0-25~~75~~%	≤0.5	1. Very Low
26-50%	≤0.5	2. Low
51-75~~25~~%	≤0.5	3. Moderate
76-100~~25~~%	≥0.5	4. High

8) Site Assessment

The overall site assessment category is determined using the decision matrix presented in Table 22. Site sediments categorized as Unimpacted or Likely Unimpacted meet the sediment quality objective protecting human consumers for the specific contaminant evaluated. Site sediments categorized as Possibly Impacted, Likely Impacted or Clearly Impacted do not meet the sediment quality objective. This evaluation is performed separately for each chemical contaminant group.

Table 22. Site Assessment Matrix

		Chemical Exposure				
		Very Low	Low	Moderate	High	Very High
Site Sediment Linkage	Very Low	Unimpacted	Unimpacted	Likely Unimpacted	Likely Unimpacted	Likely Unimpacted
	Low	Unimpacted	Unimpacted	Likely Unimpacted	Possibly Impacted	Likely Impacted
	Mod	Unimpacted	Likely Unimpacted	Likely Impacted	Likely Impacted	Clearly Impacted
	High	Unimpacted	Likely Unimpacted	Likely Impacted	Clearly Impacted	Clearly Impacted

e. Tier 3 Assessment

1) Purpose

A Tier 3 assessment may be performed to address unique situations or evaluate additional factors affecting the assessment not considered in Tier 2. Tier 3 may be performed to

- Improve accuracy and precision of the Tier 2 assessment
- Evaluate different risk related assumptions
- Incorporate spatial and temporal factors into the assessment
- Evaluate specific subareas, contaminant gradients or potential hotspots

Tier 3 may be performed at any time, ~~with approval from the Regional Board~~ provided that Tier 2 is completed at the same time. A change in any parameter or model from that used in Tier 2 must be justified based on site conditions in comparison to Tier 2 assumptions and values, and approved by the Regional Water Board prior to performing the analysis.

2) Tier 3 triggering criteria

In order to proceed with Tier 3 assessment, a site must meet one of the following conditions:

a. Variation in factors or processes are present that affect contaminant bioaccumulation from sediment, resulting in a difference in Sediment Linkage category. Examples of the factors include

   i. Differences in the relationship between geochemical characteristics and contaminant bioavailability
   ii. Differences in physiological processes affecting bioaccumulation model performance, such as growth rate or assimilation efficiency
   iii. Measured sediment concentrations are not representative of actual fish forage area due to spatial or temporal variations in sediment contaminant distribution, fate, or transport
   iv. Differences in food web or forage range of target species
   v. Use of alternate sportfish species other than those in Appendix A-6.
   vi. Changes in exposure factors that result in a difference in chemical exposure category
   vii. Consumption rate
   viii. Proportion of each sportfish species consumed by humans

3) Site Assessment

Tier 3 assessments shall utilize the same framework indicators and decision criteria described in in Tier 2 and presented in Tables 20, 21, and 22. With exception of assessment of substance consumers.

Tier 3 assessments for subsistence consumers may be accomplished by adjusting the chemical exposure thresholds to provide an equivalent level of health protection as described in OEHHA 2008. If chemical exposure assessment requires evaluation of subsistence fishers, thresholds based on Office of Environmental Health Hazard Assessment (OEHHA) Advisory Tissue Level based on 4 or 5 day consumption rate shall be applied in lieu of those provided in Table 16, in consultation with OEHHA to ensure representative characterization of exposure. Use of subsistence thresholds shall only be applied to those waters where the Tribal Beneficial Uses or Tribal Subsistence Beneficial Uses have been designated by the applicable Regional Water Board.

3. Implementation for Assessing Wildlife and Resident Finfish

The narrative wildlife* and resident finfish* objective in Chapter III.A.2.c~~Section IV.C of this Part 1~~ shall be implemented on a case-by-case basis, based upon an ecological risk assessment. In conducting an ecological risk assessment, the Water Boards shall consider any applicable and relevant ecological risk information, including policies and guidance from the following sources:

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

When threatened or endangered species are present in enclosed bays and estuaries, the Water Boards shall consult with State and/or Federal Resource Trustee agencies to ensure that these species are adequately protected.

4. ~~VII.~~ Program Specific Implementation

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

a. Implementation of Sediment Quality Objectives

Implementation of the Sediment Quality Provisions shall be conducted in accordance with the following provisions and consistent with the process shown in Appendix A-1 and A-2.

Each sediment quality objective is evaluated independently using the applicable methods described in Chapters IV.A.1 through IV.A.3. Because each objective addresses a different receptor and/or exposure pathway, sediments that meet one objective may not meet the other objective. As a result, each determination is also independent. An important difference is the spatial scale of the assessment. Compliance with aquatic life objective is determined based on the individual assessment of two or more stations within a site. Compliance with the sportfish objective is based on an overall assessment of a site that encompasses multiple sediment and tissue samples from the site. As a result, assessment of sediment quality relative to each objective may require a unique study design; however, this does not imply that the same sediment chemistry samples and other data cannot be applied to both aquatic life and sportfish-based assessment frameworks.

b. ~~A.~~ Dredge Materials

1) ~~1. Part 1~~The Sediment Quality Provisions shall not apply to dredge material suitability determinations.

2) ~~2.~~ The Water Boards shall not approve a dredging project that involves the dredging of sediment that exceeds the objectives in ~~Part 1~~the Sediment Quality Provisions, unless the Water Boards determine that:

a. The polluted sediment is removed in a manner that prevents or minimizes water quality degradation.

b. The polluted sediment is not deposited in a location that may cause significant adverse effects to aquatic life, fish, shellfish, or wildlife or may harm the beneficial uses of the receiving waters, or does not create maximum benefit to the people of the State.

c. The activity will not cause significant adverse impacts upon a federal sanctuary, recreational area, or other waters of significant national importance.

c. ~~B.~~ NPDES Permits

1) Receiving Water and Effluent Limits for SQOs

a. ~~1.~~ If a Water Board determines that discharge of a toxic or bioaccumulative pollutant to bay or estuarine waters has the reasonable potential to cause or contribute to an exceedance of the SQOs, the Water Board shall apply the objectives as receiving water limits.

b. ~~2.~~ The Permittee shall be in violation of such limits if it is demonstrated that the discharge is causing or contributing to the SQO exceedance as defined in Chapter IV.A.4.c.2)~~Section VIII.C.~~

c. ~~3.~~ Receiving water monitoring required by an NPDES permit may be satisfied by a Permitee's participation in a regional SQO monitoring program described in Chapter IV.A.4.d~~Section VIII.D.~~

d. ~~4.~~ The sediment chemistry guidelines presented in Tables 6 and 7 shall not be translated into or applied as effluent limits. Effluent limits established to protect or restore sediment quality shall be developed only after:

i. ~~a.~~ A clear relationship has been established linking the discharge to the degradation,

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

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

These actions are described further in Chapters IV.A.4.f and IV.A.4.g~~Sections VII.F and VII.G~~. Nothing in this chapter~~section~~ shall limit a Water Board's authority to develop and implement waste* load allocations* for Total Maximum Daily Loads. However, it is recommended that the Water Boards develop TMDL allocations using the methodology described herein, wherever possible.

2) ~~C.~~ Exceedance of Receiving Water Limit

a. Exceedance of a receiving water limit to protect aquatic life as described in Chapter III.A.2.a is demonstrated when:

i. ~~i.~~ Any station within the site is assessed as Clearly Impacted as defined in Chapter IV.A.1.i and IV.A.1.j or:~~1. Using a binomial distribution*, the total number of stations designated as not meeting the protective condition as defined in Sections V.I.4. or V.J.4. supports rejection of the null hypothesis* as presented in Table 15. The stations included in this analysis will be those located in the vicinity of the discharge and identified in the permit, and~~

ii. The total percent area categorized as Possibly Impacted and/or Likely Impacted equals or exceeds 15 percent of the site area over the duration of a permit cycle. Calculation of percent area shall be based on data from spatially representative samples selected using a randomized study design or equivalent spatial analysis. Where impacted stations consist entirely of Possibly Impacted, confirmation monitoring may be conducted to verify that impacts are present, and

iii. ~~i~~ ~~2.~~ It is demonstrated that the discharge is causing or contributing to the SQO exceedance, following the completion of the stressor identification studies described in Chapter IV.A.4.f~~Section VII.F~~.

iv. ~~ii~~ ~~3.~~ If studies by the Permittee demonstrate that other sources may also be contributing to the degradation of sediment quality, the Regional Water Board shall, as appropriate, require the other sources to initiate studies to assess the extent to which these sources are a contributing factor.

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

~~Sample Size~~	~~List If the Number of Exceedances Equals or Is Greater Than~~
~~2 – 24~~	~~2*~~
~~25 – 36~~	~~3~~
~~37 – 47~~	~~4~~
~~48 – 59~~	~~5~~
~~60 – 71~~	~~6~~

~~72 – 82~~	~~7~~
~~83 – 94~~	~~8~~
~~95 – 106~~	~~9~~
~~107 – 117~~	~~10~~
~~118 – 129~~	~~11~~

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

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

b. Exceedance of the receiving water limit to protect human consumers of sportfish as described in Chapter III.A.2.b is demonstrated when:

i. The site sediments are categorized as Possibly Impacted, Likely Impacted or Clearly Impacted over the duration of a permit cycle. When the site is categorized as Possibly Impacted, confirmation monitoring may be conducted to verify that an impact is present; and

ii. It is demonstrated that the discharge is causing or contributing to the SQO exceedance.

Exceedance will require the Permittee to perform additional studies as described in Chapters IV.A.4.f~~Sections VIII.F~~.

3) ~~D.~~ **Receiving Water Limits Monitoring Frequency**

a. ~~1.~~ Phase I Stormwater Discharges and Major Discharges—Sediment Monitoring shall not be required less frequently than ~~twice~~once per permit cycle. For Stations that are consistently classified as Unimpacted or Likely Unimpacted the frequency may be reduced to once per permit cycle. The Water Board may limit receiving water monitoring to a subset of outfalls for Phase I Stormwater Permitees.

b. ~~2.~~ Phase II Stormwater and Minor Discharges—Sediment Monitoring shall not be required more often than twice per permit cycle or less than once per permit cycle. For stations that are consistently classified as Unimpacted or Likely Unimpacted, the number of stations monitored may be reduced at the discretion of the Water Board. The Water Board may limit receiving water monitoring to a subset of outfalls for Phase II Stormwater Permitees.

c. ~~3.~~ Other Regulated Discharges and Waivers—The frequency of the monitoring for receiving water limits for other regulated discharges and waivers will be determined by the Water Board.

d. ~~E.~~ Sediment Monitoring and Assessment

1) ~~1.~~ Objective—Bedded sediments in bays contain an accumulation of pollutants from a wide variety of past and present sources discharged either directly into the bay or indirectly into waters draining into the bay. Embayments also represent highly disturbed or altered habitats as a result of dredging and physical disturbance caused by construction and maintenance of harbor works, boat and ship traffic, and development of adjacent lands. Due to the multitude of stressors and the complexity of the environment, a well-designed monitoring program is necessary to ensure that the data collected adequately characterizes the condition of sediment in these water bodies.

2) ~~2.~~ Permitted Discharges—Monitoring may be performed by individual Permitees to assess compliance with receiving water limits, or through participation in a regional or water body monitoring coalition as described under Chapter IV.A.4.d~~VIII.ED.3~~, or both as determined by the Water Board.

3) ~~3.~~ Monitoring Coalitions—To achieve maximum efficiency and economy of resources, the State Water Board encourages the regulated community in coordination with the Regional Water Boards to establish water body-monitoring coalitions. Monitoring coalitions enable the sharing of technical resources, trained personnel, and associated costs and create an integrated sediment-monitoring program within each major water body. Focusing resources on regional issues and developing a broader understanding of pollutants effects in these water bodies enables the development of more rapid and efficient response strategies and facilitates better management of sediment quality.

   a. If a regional monitoring coalition is established, the coalition shall be responsible for sediment quality assessment within the designated water body and for ensuring that appropriate studies are completed in a timely manner.

   b. The Water Board shall provide oversight to ensure that coalition participants are proactive and responsive to potential sediment quality related issues as they arise during monitoring and assessment.

   c. Each regional monitoring coalition shall prepare a workplan that describes the monitoring, a map of the stations, participants and a schedule that shall be submitted to the Water Board for approval.

4) ~~4.~~ Methods—Sediments and tissues collected from each station or site shall be tested and ~~or~~ assessed using the methods and metrics described in Chapter IV.A.1 through VI.A.3~~Section V~~.

5) ~~5.~~ Design.

   a. The design of sediment monitoring programs, whether site-specific or region wide, shall be based upon a conceptual model. A conceptual model is useful for identifying the physical and chemical factors that control the fate and transport of pollutants and receptors that could be exposed to pollutants in the sediment. See Appendix A-5 for detailed explanation and direction. The conceptual model serves as the basis for assessing the appropriateness of a study design. The detail and complexity of the conceptual model is dependent upon the scope and scale of the monitoring program or tiered assessment. A conceptual model ~~shall~~may consider:

- Points of discharge into the segment of the waterbody or region of interest
- Tidal flow and/or direction of predominant currents
- Historic and or legacy conditions in the vicinity
- Nearby land and marine uses or actions
- Beneficial uses
- Potential receptors of concern
- Changes in grain size salinity water depth and organic matter
- Other sources or discharges in the immediate vicinity.
- Site boundaries and site size
- Sportfish consumer population characteristics (e.g. consumption rate)
- Sportfish species to be monitored
- Food web associated with sportfish species to be monitored
- Site-specific modifications to the bioaccumulation model parameters (e.g. sportfish movement range or diet) as needed.

A definition of the site boundaries and site size is needed to aid in data collection and data reduction, in addition to being a key input for the sediment linkage indicator as described in Appendix A-5. Selection of sportfish species of interest should to the extent the information is available, be based on the fishing and consumption practices of local consumers as well as species known to reside in the site, and representing predominant dietary guilds.

b. Sediment monitoring programs shall be designed to ensure that the aggregate stations are spatially representative of the sediment within the water body.

c. The design shall take into consideration existing data and information of appropriate quality.

d. Stratified random design shall be used where resources permit to assess conditions throughout a water body.

e. Identification of appropriate strata shall consider characteristics of the water body including sediment transport, hydrodynamics, depth, salinity, land uses, inputs (both natural and anthropogenic) and other factors that could affect the physical, chemical, or biological condition of the sediment.

f. Targeted designs shall be applied to those Permittees that are required to meet receiving water limits as described in Chapter IV.A.4.c.2).~~Section VII.B~~.

6) ~~6.~~ Index Period—All stations shall be sampled between the months of June through September to be consistent with the benthic community condition index period.

7) ~~7.~~ Regional Monitoring Schedule and Frequency.

a. Regional sediment quality monitoring will occur at a minimum of once every ~~three~~ five years.

b. Sediments identified as exceeding the narrative objective must~~will~~ be evaluated more frequently.

8) Confirmation Monitoring – Repeat monitoring conducted at the same and/or additional stations to confirm the categorization of a site or multiple stations as Possibly Impacted. Monitoring methods are the same as those used in the prior assessment.

e. ~~8.~~ Evaluating Waters for Placement of the Section 303(d) List

1) Aquatic Life – Benthic Community Protection

In California, water segments are placed on the section 303(d) list for sediment toxicity based either on toxicity alone or toxicity that is associated with a pollutant. The listing criteria are contained in the State Water Board's Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List ~~(2004)~~ (Listing Policy). ~~Part 1~~The Sediment Quality Provisions adds an additional listing criterion that applies only to listings for exceedances of the narrative sediment quality objective for aquatic life protection in Chapter III.A.2.a~~Section IV.A~~. The criterion under ~~Part 1~~the Sediment Quality Provisions is described in subchapter ~~i~~ a~~subsection a~~. below and the relationship between the sediment toxicity listing criteria under the Listing Policy and the criterion under ~~Part 1~~the Sediment Quality Provisions is described in subchapter c. and d. ~~subsections b. and c.~~, below.

a. ~~1.~~ Water segments shall be placed on the section 303(d) list for exceedance of the narrative sediment quality objective for aquatic life protection in Chapter III.A.2.a of the Sediment Quality Provisions~~Section IV.A. of Part 1~~ only if ~~the number of stations designated as not achieving the protective condition as defined in Sections V.I. and V.J. supports rejection of the null hypothesis, as provided in Table 3.1 of the State Water Board's Listing Policy.~~

i. Any station within the site is assessed as Clearly Impacted as defined in Chapter IV A.1.i and IV.A.1.j or

ii. The total percent area categorized as Possibly Impacted and/or Likely Impacted equals or exceeds 15 percent of the site area over the duration of a listing cycle. Calculation of percent area shall be based on data from multiple spatially representative samples selected using a randomized study design or equivalent spatial analysis. Where impacted stations consist entirely of Possibly Impacted, confirmation monitoring may be conducted to verify that impacts are present.

b. Data to be evaluated shall include all relevant data collected from monitoring programs conducted over the duration of the listing cycle (6 years).

c. ~~2.~~ Water segments that exhibit sediment toxicity but that are not listed for an exceedance of the narrative sediment quality objective for aquatic life protection in Chapter III.A.2.a~~Section IV.A.~~ shall continue to be listed in accordance with Section 3.6 of the Listing Policy.

d. ~~3.~~ If a water segment is listed under Section 3.6 of the Listing Policy and the Regional Water Board later determines that the applicable water quality standard that is impaired consists of the sediment quality objective in Chapter III.A.2.a of the Sediment Quality Provisions~~Section IV.A. of Part 1~~ and a bay or estuarine habitat beneficial use, the Regional Water Board shall reevaluate the listing in accordance with Chapters IV.A.1.i and IV.A.1.j~~Sections V.I and V.J~~. If the Regional Water Board reevaluates the listing and determines that the water segment does not meet the criteria in Chapter IV.A.4.e.1)a.~~subchapter i.~~~~subsection a.~~ above, the Regional Water Board shall delist the water segment.

2) Human Health - Water segments shall be placed on the section 303(d) list for exceedance of the narrative sediment quality objective for human health protection in Chapter III.A.2.b of the Sediment Quality Provisions if sediments from a site are categorized as Possibly Impacted, Likely Impacted or Clearly Impacted over the duration of the listing cycle (6 years). When the segment is categorized as possibly impacted, confirmation monitoring may be conducted to verify that an impact is present.

3) ~~Site sediment~~Segment evaluation for Chapters IV.A.4.e.1) and IV.A.4.e.2) above, shall use the methods described in Chapters IV.A.4.d.4)-IV.A.4.d.7) and meet the following requirements:

   a. Data used in the evaluation must be obtained from multiple spatially representative stations.
   b. Data used in the evaluation must be obtained from multiple surveys over a span of at least one year.

4) Water segments shall be removed from the section 303(d) list if the listing thresholds are not exceeded over the duration of the listing cycle and satisfy the requirements under Chapter IV.A.4.e.3) above.

f. ~~F.~~ Stressor Identification

If sediments fail to meet the narrative SQOs in accordance with Chapters IV.A.1 through IV.A.3~~Sections V. and VI~~. the Water Boards shall direct the regional monitoring coalitions or Permittees to conduct stressor identification.

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

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

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

1) ~~1.~~ Confirmation and Characterization of Pollutant Related Impacts—Exceedance of the aquatic life direct effects SQO at a site indicates that pollutants in the sediment are the likely cause but does not identify the specific pollutant responsible. The MLOE assessment establishes a linkage to sediment pollutants; however, the lack of confounding factors (e.g., physical disturbance, non-pollutant constituents) must be confirmed. There are two generic stressors that are not related to toxic pollutants that may cause the narrative to be exceeded:

   a. Physical Alteration—Examples of physical stressors include reduced salinity, impacts from dredging, very fine or coarse grain size, and prop wash from passing ships. These types of stressors may produce a non-reference condition* in the benthic community that is similar to that caused by pollutants. If impacts to a site are purely due to physical disturbance, the LOE characteristics will likely show a degraded benthic community with little or no toxicity and low chemical concentrations.

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

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

a. Evaluate the spatial extent of the Area of Concern. This information can be used to evaluate the potential risk associated with the sediment, distinguish areas of known physical disturbance or pollution and evaluate the proximity to anthropogenic source gradient from such inputs as outfalls, storm drains, and industrial and agricultural activities.

b. Body burden data may be examined from animals exposed to the site's sediment to indicate if pollutants are being accumulated and to what degree.

c. Chemical specific mechanistic benchmarks* may be applied to interpret sediment chemistry concentrations.

d. Chemistry and biology data from the site should be examined to determine if there is a correlation between the two LOE.

e. Alternate biological effects data may be pursued, such as bioaccumulation* experiments and pore water toxicity or chemical analysis.

f. Other investigations that may commonly be performed as part of a Phase 1 Toxicity Identification Evaluation* (TIE).

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

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

a. Statistical methods—Correlations between individual chemicals and biological endpoints (toxicity and benthic community).

b. Gradient analysis—Comparisons are made between different samples taken at various distances from a chemical hotspot to examine patterns in chemical concentrations and biological responses. The concentrations of causative agents should decrease as biological effects decrease.

c. Additional Toxicity Identification Evaluation efforts—A toxicological method for determining the cause of impairments is the use of toxicity identification evaluations (TIE). Sediment samples are manipulated chemically or physically to remove classes of chemicals or render them biologically unavailable. Following the manipulations, biological tests are performed to determine if toxicity has been removed. TIEs should be conducted at a limited number of stations, preferably those with strong biological or toxicological effects.

d. Bioavailability*—Chemical pollutants may be present in the sediment but not biologically available to cause toxicity or degradation of the benthic community. There are several measures of bioavailability that can be made. Chemical and toxicological measurements can be made on pore water to determine the availability of sediment pollutants. Metal compounds may be naturally bound up in the sediment and rendered unavailable by the presence of sulfides. Measurement of acid volatile sulfides and simultaneously extracted metals analysis can be conducted to determine if sufficient sulfides are present to bind the observed metals. Similarly, organic compounds can be tightly bound to sediments. Measurements of sediment organic carbon and other binding phases can be conducted to determine the bioavailable fraction of organic compounds. Solid phase microextraction (SPME) or laboratory desorption experiments can also be used to identify which organics are bioavailable to benthic organisms.

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

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

4) ~~3.~~ Sources Identification and Management Actions.

a. Determine if the sources are ongoing or legacy sources.

b. Determine the number and nature of ongoing sources.

c. If a single discharger is found to be responsible for discharging the stressor pollutant at a loading rate that is significant, the Regional Water Board shall require the discharger to take all necessary and appropriate steps to address exceedance of the SQO, including but not limited to reducing the pollutant loading into the sediment.

d. When multiple sources are present in the water body that discharge the stressor pollutant at a loading rate that is significant, the Regional Water Board shall require the sources to take all necessary and appropriate steps to address exceedance of the SQO. If appropriate, the Regional Water Board may adopt a TMDL to ensure attainment of the sediment standard.

g. ~~G.~~ Cleanup and Abatement

Cleanup and abatement actions covered by Water Code section 13304 for sediments that exceed the objectives in Chapter IV shall comply with Resolution No. 92-49 (Policies and Procedures for Investigation and Cleanup and Abatement of Discharges under Water Code Section 13304), Cal. Code Regs., tit. 23, §§ 2907, 2911. In addition, all cleanup and abatement actions must comply with California Environmental Quality Act (CEQA), Public Resources Code §21000 et seq.

h. ~~H.~~ Development of Site-Specific Sediment Management Guidelines

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

Development of site-specific sediment management guidelines is the process to estimate the level of the stressor pollutant that will meet the narrative sediment quality objective. The guideline can serve as the basis for cleanup goals or revision of effluent limits described in Chapter IV.A.4.b.4) ~~B. 4~~ above, depending upon the situation or sources. All guidelines when applied for cleanup, must comply with Resolution No. 92-49.

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

a. ~~1.~~ Correspondence with sediment chemistry. An effective guideline can best be derived based upon the site-specific, or reach- specific relationship between the stressor pollutant exposure and biological response. Therefore the correspondence between the bulk sediment stressor concentration and biological effects should be examined.

b. ~~2.~~ Correspondence with bioavailable pollutant concentration. The concentration of the bioavailable fraction of the stressor pollutants is likely to show a less variable relationship to biological effects than~~t~~ bulk sediment chemistry. Interstitial water analysis, SPME, desorption experiments, selective extractions, or mechanistic models may indicate the bioavailable pollutant concentration. The correspondence between the bioavailable stressor concentration and biological effects should be examined.

c. ~~3.~~ Correspondence with tissue residue. The concentration of the stressor accumulated by a target organism may provide a measure of the stressor dose for some chemicals (e.g., those that are not rapidly metabolized). The tissue residue threshold concentration associated with unacceptable biological effects can be combined with a biota-sediment accumulation factor or model to estimate the loading or sediment concentration guideline.

d. ~~4.~~ Literature review. If site-specific analyses are ambiguous or unable to determine a guideline, then the results of similar development efforts for other areas should be reviewed. Scientifically credible values from other studies can be combined with mechanistic or empirical models of bioavailability, toxic potency, and organism sensitivity to estimate guidelines for the area of interest.

e. ~~5.~~The chemistry LOE of Chapter IV.A.1.h.2)~~Section V.H.2~~, including the threshold values (e.g. CSI and CALRM), shall not be used for setting cleanup levels or numeric values for technical TMDLs.

2) Human Health Protection - Development of management guidelines for human health should be based upon site-specific biota-sediment accumulation factors for sportfish derived using bioaccumulation modeling. The goal is to determine a sediment contaminant concentration that will result in acceptable levels of tissue contamination in site sportfish. The following approach can be applied to develop these guidelines:

a. Calculation of sediment concentration (Cs) corresponding to attainment of acceptable sportfish contaminant concentration based on biota-sediment accumulation factor ($BSAF_{95}$).

Equation 10 Cs = Ctt/BSAF95 where:

Cs = sediment management concentration (ng/g dry wt);

Ctt = tissue threshold (ng/g wet wt) corresponding to OEHHA ATL3

$BSAF_{95}$ = highest upper 95th percentile of BSAF derived from bioaccumulation model for species used in the assessment

b. Empirical BSAFs derived from site tissue and sediment data may be used when appropriate model-based BSAFs are not available

c. Calculation of sediment guidelines according to a and b (above) are based on the assumption that site sediment contamination is the primary determinant of tissue contamination. In situations where other contamination sources are important, such as water column contamination from offsite areas or watershed inputs, these approaches may not achieve the desired tissue contaminant levels. In such situations, the contributions from these additional sources should be accounted for when deriving management guidelines.

d. Regional background contamination should be taken into account when establishing management guidelines or actions. Regional background is defined as the concentration of contaminant that is primarily attributable to diffuse sources, not attributable to a specific source or release. It is not feasible to establish management guidelines for a site that are below regional background, as they cannot be expected to be attained within a defined timeframe. Instead, such values should be regarded as management goals to inform watershed-based management plans.

3) The assessment categorical results of Unimpacted and Likely Unimpacted may be used as alternative sediment management guidelines in lieu of numeric targets.

V. ~~VIII.~~ GLOSSARY

ADVISORY TISSUE LEVEL (ATL): Developed by CalEPA Office of Environmental Health Hazard Assessment that serve as the basis for consumption advice for consumption of fish in California.

AQUATIC LIFE: For the purpose of ~~this Part 1~~the Sediment Quality Provisions, aquatic life refers to benthic invertebrates, shellfish sport fish and finfish.

BAYS: For the purpose of ~~this Part 1~~the Sediment Quality Provisions, bays are defined as enclosed bays*.

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

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

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

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

BIOTA-SEDIMENT ACCUMULATION FACTOR (BSAF): wet weight chemical concentration in biota (ng/g) divided by dry weight chemical concentration in sediment (ng/g).

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

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

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

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

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

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

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

FISH CONTAMINANT GOAL (FCG): Developed by CalEPA Office of Environmental Health Hazard Assessment to provide fish tissue goal for pollution mitigation or elimination.

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

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

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

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

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

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

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

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

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

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

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

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

RESIDENT FINFISH: Any species of bony fish or cartilaginous fish (sharks, skates and rays) whose home range occupies all or part of the water body but does not extend into other water bodies.

SPECIES RICHNESS: The number of species in a sample.

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

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

TOTAL CHLORDANES: SUM of alpha Chlordane, gamma Chlordane, cis-Nonachlor, trans-Nonachlor, and Oxychlordane.

TOTAL DDTS: Sum of o,p'-DDE, o,p'-DDD, o,p'-DDT, p,p'-DDD, p'p'-DDE, and p,p'-DDT..

TOTAL PCBS: Sum of all PCB congeners listed in Table A-7.

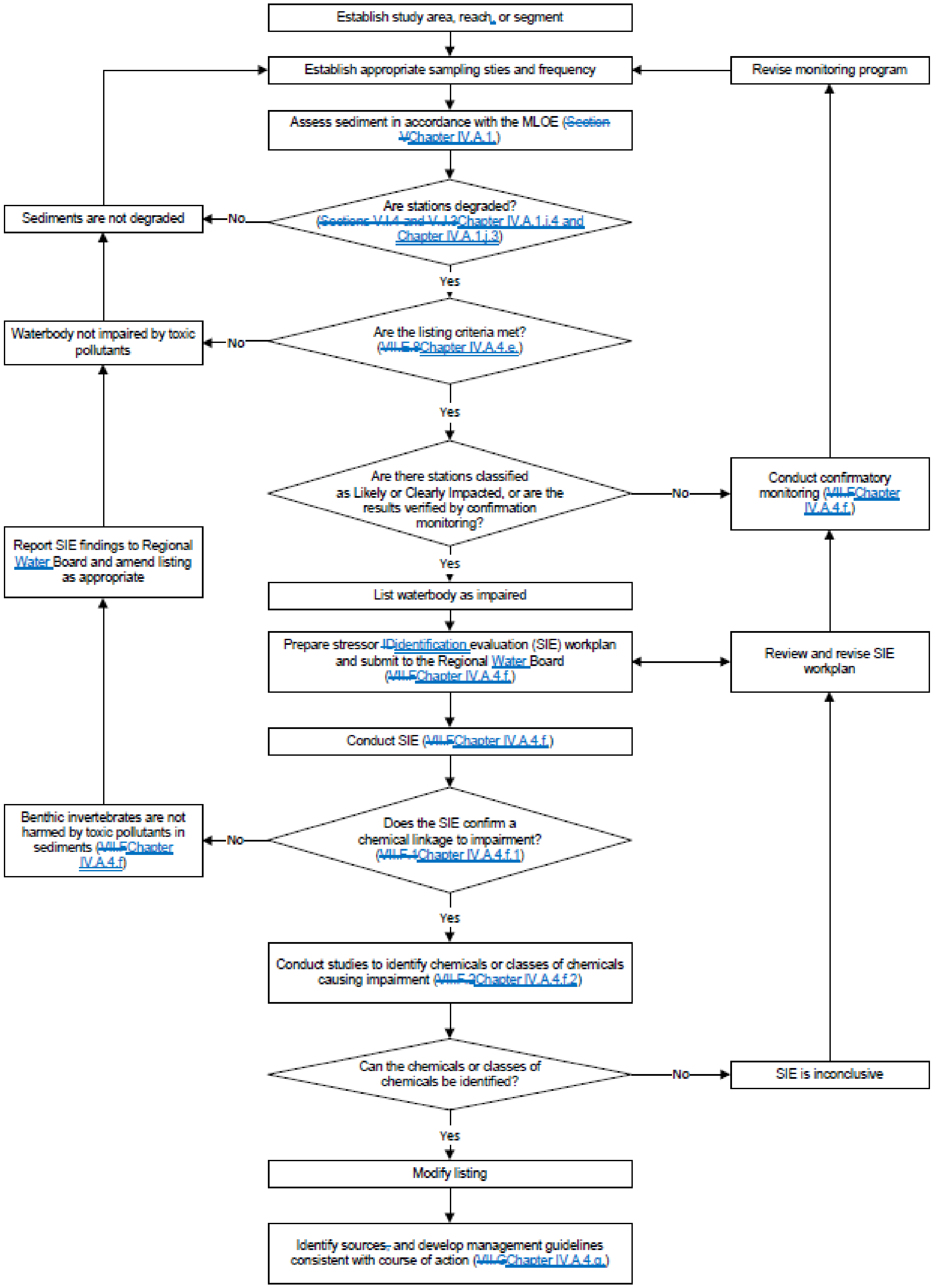
TOXICITY IDENTIFICATION EVALUATION (TIE): Techniques used to identify the unexplained cause(s) of toxic events. TIE involves selectively removing classes of chemicals through a series of sample manipulations, effectively reducing complex mixtures of chemicals in natural waters to simple components for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

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

WILDLIFE: All tetrapod vertebrates, including amphibians, reptiles, birds and mammals, inclusive of marine mammals.

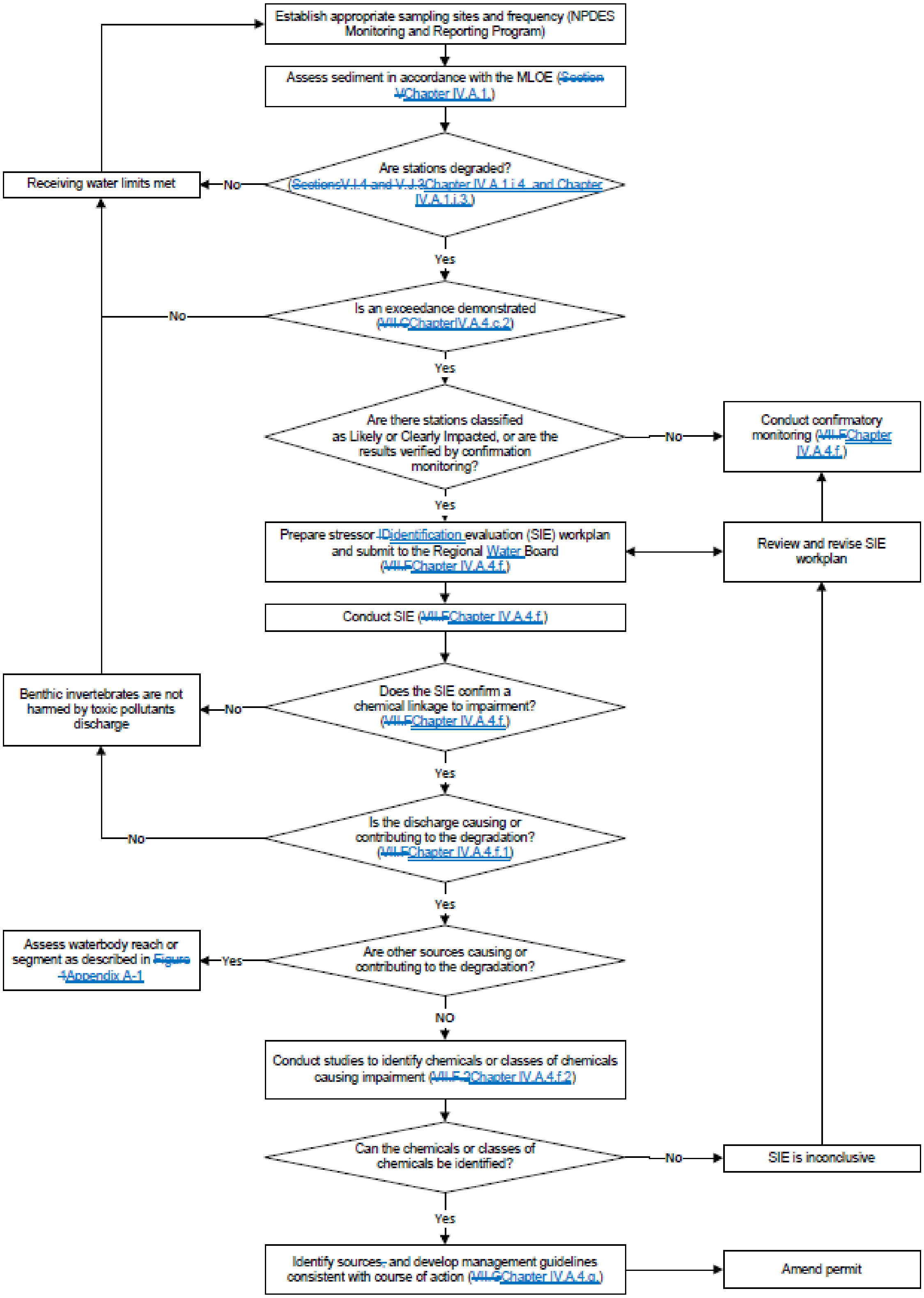
APPENDICIES

APPENDIX A-1: FIGURE OF WATERBODY ASSESSMENT PROCESS FOR BENTHIC COMMUNITY PROTECTION



~~Figure 1. Waterbody Assessment Process~~

~~APPENDIX A-2: FIGURE OF POINT SOURCE ASSESSMENT PROCESS~~ FOR BENTHIC COMMUNITY PROTECTION



~~**Figure 2. Point Source Assessment Process**~~

APPENDIX A-3: ~~Attachment A.~~ LIST OF CHEMICAL ANALYTES NEEDED TO CHARACTERIZE SEDIMENT CONTAMINATION EXPOSURE AND EFFECT FOR BENTHIC COMMUNITY PROTECTION.

Chemical Name	Chemical Group	Chemical Name	Chemical Group
Total Organic Carbon	General	Alpha Chlordane	Pesticide
Percent Fines	General	Gamma Chlordane	Pesticide
		Trans Nonachlor	Pesticide
Cadmium	Metal	Dieldrin	Pesticide
Copper	Metal	o,p'-DDE	Pesticide
Lead	Metal	o,p'-DDD	Pesticide
Mercury	Metal	o,p'-DDT	Pesticide
Zinc	Metal	p,p'-DDD	Pesticide
		p,p'-DDE	Pesticide
		p,p'-DDT	Pesticide
Acenaphthene (L)	PAH	2,4'-Dichlorobiphenyl(PCB8)	PCB congener
Anthracene (L)	PAH	2,2',5-Trichlorobiphenyl(PCB18)	PCB congener
Biphenyl (L)	PAH	2,4,4'-Trichlorobiphenyl(PCB28)	PCB congener
Naphthalene (L)	PAH	2,2',3,5'-Tetrachlorobiphenyl(PCB44)	PCB congener
2,6-dimethylnaphthalene (L)	PAH	2,2',5,5'-Tetrachlorobiphenyl(PCB52)	PCB congener
Fluorene (L)	PAH	2,3',4,4'-Tetrachlorobiphenyl(PCB66~~0~~)	PCB congener
1-methylnaphthalene (L)	PAH	2,2',4,5,5'-Pentachlorobiphenyl(PCB101)	PCB congener
2-methylnaphthalene (L)	PAH	2,3,3',4,4'-Pentachlorobiphenyl(PCB105)	PCB congener
1-methylphenanthrene (L)	PAH	2,3,3',4',6-Pentachlorobiphenyl (PCB110)	PCB congener
Phenanthrene (L)	PAH	2,3',4,4',5-Pentachlorobiphenyl(PCB118~~23~~)	PCB congener
Benzo(a)anthracene (H)	PAH	2,2',3,3',4,4'-Hexachlorobiphenyl(PCB128)	PCB congener
Benzo(a)pyrene (H)	PAH	2,2',3,4,4',5'-Hexachlorobiphenyl(PCB138)	PCB congener
Benzo(e)pyrene (H)	PAH	2,2',4,4',5,5'-Hexachlorobiphenyl(PCB153)	PCB congener
Chrysene (H)	PAH	~~2,2',3,3',4,4',5-Heptachlorobiphenyl(PCB170)~~	PCB congener
Dibenz(a,h)anthracene (H)	PAH	2,2',3,4,4',5,5'-Heptachlorobiphenyl(PCB180)	PCB congener
Fluoranthene (H)	PAH	2,2',3,4',5,5',6-Heptachlorobiphenyl(PCB187~~5~~)	PCB congener
Perylene (H)	PAH	2,2',3,3',4,4',5,6-Octachlorobiphenyl(PCB195)	PCB congener
Pyrene (H)	PAH	~~2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl(PCB206)~~	PCB congener
		~~Decachlorobiphenyl(PCB209)~~	PCB congener

(L) = Low molecular weight PAH
(H) = High molecular weight PAH

APPENDIX A-4: ~~Attachment B.~~ STATION ASSESSMENT CATEGORY RESULTING FROM EACH POSSIBLE MLOE COMBINATION

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

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

APPENDIX A-5: DESIGN CONSIDERATIONS FOR HUMAN HEALTH SQO ASSESSMENT.

The first step in site assessment for the human health SQO is to develop a conceptual site model (CSM) that describes the specific site or waterbody characteristics, contaminants, receptors, and sources that are important to the study design. This is needed to determine key assessment design elements, such as site size, sportfish species to monitor, and number of samples to collect. A CSM generally includes a written description of the specific issues associated with a site, as well as a graphical depiction of contaminant sources, processes, and receptors (i.e., target species). The graphical depiction aids in beginning to identify potential linkages, as well as sources of uncertainty, such as what types of anglers capture and consume fish from the site, how frequently does fishing activity occur, and what seafood species occur on the site. The detail and complexity of the conceptual model is dependent upon the scope and scale of the assessment. For Tier 1, a limited CSM that focuses primarily on site boundaries, historical data availability, and basis for the selection of fish species may be appropriate.

The CSM should be based on local information and expertise, and developed in a collaborative process that includes local environmental managers, stakeholders, and scientists. The CSM can be informed by prior and ongoing scientific activities, including literature, prior field data collection, anecdotal evidence, and modeling activities. This information should be documented as part of CSM development. Issues to be considered and addressed include: model assumptions; key processes; spatial and temporal scales of interest; system characteristics and behaviors; available data sources and collection programs; and data gaps. The CSM should be written in clear language with a minimum of jargon.

The CSM should identify water body characteristics, key exposure pathways, and areas of uncertainty. For the human health SQO, exposure pathways are defined, a priori, as human consumption of contaminated sportfish. However, there are site-specific aspects of consumption that should be addressed in the CSM. Specifically, the CSM should contain information needed to determine the following study design parameters:

- Site boundaries and site size
- Sportfish consumer population characteristics (e.g., consumption rate)
- Fish species to be monitored
- Food web associated with target sportfish species
- Site-specific modification to other parameters (e.g., sportfish movement range or diet) as needed
- Sediment contaminant sources
- Contaminant fate and transport mechanisms

A definition of the site boundaries and site size is needed to aid in data collection and data reduction, in addition to being a key input for the sediment contribution indicator. A site for SQO assessment is defined as an area of sufficient size to encompass key elements of the food web responsible for fish tissue contamination. The site should be large enough to include most of the foraging activities of the target sportfish, but not so large as to obscure linkages between sediment and tissue contamination. Site boundaries may be defined based on geomorphic and hydrologic boundaries, fish movement patterns, areas of management concern, previous boundary definitions (e.g., water body segments), and other local considerations.

Site size (area or length) may influence the accuracy of the site linkage indicator. The bioaccumulation modeling approach used in the assessment framework incorporates a site use factor that represents the proportion of sportfish foraging activity that occurs within the site. Use of a site that is substantially smaller than the forage area of the target sportfish will reduce the apparent linkage of the site sediment to fish bioaccumulation and may result in an underestimate of the site linkage. Selection of a very large site for assessment may also result in an underestimate of site linkage because of spatial variation in sediment contamination or foraging activity within the site. For example, the average sediment contaminant concentration over a large area may not accurately represent the concentration in subareas of the site that represent the main forage area or the fish. A minimum site area of 1 km^2 is required for Tier 2 assessment, as this area encompasses a large portion of the forage range for most of the primary sportfish species for assessment. Application of the Tier 2 methodology to smaller sites is likely to provide an inaccurate site linkage evaluation because uptake from foraging activities outside of the site is not specifically considered. Assessment of sites <1km^2 may require a Tier 3 assessment and use of an alternative bioaccumulation model. For ~~small~~ sites of 1-10 km^2, California halibut or striped mullet should not be included as target species because their forage range is much larger than the site.

Another consideration is the spatial distribution of sediment contamination within a site. Some sites may contain specific areas of elevated contamination (“hotspots”), and it may be worthwhile to perform the assessment at multiple scales, including the hotspots, as well as less contaminated areas, to determine whether the assessment outcome would be different. During the CSM development, it would be useful to compile existing data on contamination in sportfish and sediment, and plot the results to examine the spatial distribution of contamination. Similarly, journal publications and technical reports describing contaminant sources and spatial patterns should be summarized, and local experts consulted, to identify potential hotspot areas.

The seafood consumer population is chosen based on what is known about fishing practices and consumption rates at the site. Selection of an appropriate consumer population will aid in identifying available information on local consumption rates. Surveys from other California water bodies may be employed to determine consumption rates if local data are not available. Selection of seafood species of interest will be based on the fishing and consumption practices of local consumers, as well as species known to reside in the site, and representing predominant dietary guilds. Influence of existing advisories on consumption rates should also be considered.

Additionally, the CSM can describe the broader environmental processes and pathways that affect human exposure to contaminated seafood at the site. This can include a depiction of the historic and current sources and processes that potentially result in elevated or reduced site sediment contamination. Examples of potential sources are legacy contaminated sites, agricultural or urban areas in which the contaminants were historically used. Processes that change site sediment contamination may include erosion or deposition events, or management activities that contribute to or reduce food web exposure to sediment contamination. The CSM may also include a description of other environmental matrices or areas outside the site that could result in food web contaminant exposure (e.g., known hotspots outside the site; ongoing external sources such as tributaries or storm basins). More complex contaminant fate and process information may be incorporated into a Tier 3 assessment, if deemed necessary.

CSM development is a dynamic process. As additional data and information becomes available, they are used to refine the CSM, by adding additional sources, pathways, or targets, or modifying existing linkages. Periodic refinement of the CSM may be needed to address site characteristics impacted by climate change, including changes to the food web or foraging behavior and range. As proposed in this framework an initial CSM is developed prior to Tier 1 assessment, and there is the opportunity to revisit the CSM prior to Tiers 2 and 3, if the later Tiers are conducted.

APPENDIX A-6: PRIMARY AND SECONDARY SPECIES AND ASSOCIATED DIETARY GUILD CATEGORIES USED FOR CHEMICAL EXPOSURE AND SITE~~EDIMENT~~ LINKAGE EVALUATIONS. TISSUE TYPE DENOTED BY F (SKIN OFF FILLET) OR W (WHOLE FISH, WITHOUT HEAD OR INTERNAL ORGANS)

Dietary Guild	***Description***	***Primary Guild Species***	***Secondary Guild Species***
Piscivory	The majority of the diet is fish. Large predatory invertebrates (e.g., cephalopods, decapod crustaceans, and echinoderms) are also consumed to some degree.	California halibut (F)	Pacific angel shark (F) Lingcod(F)
Benthic diet with piscivory	Diet regularly includes a mixture of benthic invertebrates and forage fish. The most diverse category. Includes two estuarine species: white catfish and channel catfish, each of which is commonly targeted by recreational anglers in the Sacramento-San Joaquin Delta (Shilling et al. 2010).	Spotted sand bass (F) White catfish (F)	Leopard shark(F) Barred sand bass(F) Bat Ray(F) Yellowfin croaker(F) Bonefish White seabass(F) Brown rockfish(F) Brown smoothhound(F) Redtail surfperch(F) Pacific sanddab(F) Grass rockfish(F) Starry flounder(F) Cabezon (F) English sole(F) Channel catfish(F)
Benthic and pelagic diet with piscivory	Diet includes a combination of benthic invertebrates, pelagic invertebrates (e.g., zooplankton, shrimp, and mysidae), and forage fish.	Queenfish(F)	Black rockfish(F) Kelp bass(F) Blue rockfish(F)
Benthic diet without piscivory	Diet largely composed of small benthic invertebrates, such as amphipods and other crustaceans, bivalve mollusks, and polychaete worms.	White croaker(F)	Spotfin croaker(F) Sargo(F) Striped seaperch(W) White seaperch(W) Pile perch(W) Walleye surfperch(W) Rubberlip seaperch(W) Barred surfperch(W) Fantail sole(F)
Benthic and pelagic diet without piscivory	Diet includes a mixture of epibenthic and pelagic invertebrates (e.g., zooplankton, shrimp, and mysids).	Shiner perch(W)	Black perch(W) Dwarf perch(W)
Benthic diet with herbivory	Largely consumes benthic invertebrates, benthic algae, and aquatic plants. Includes common carp, an estuarine species captured in the Delta	Common carp(F)	Monkeyface prickleback(F) Señorita(W)
Benthic and pelagic diet with herbivory	Diet consists of benthic and pelagic invertebrates and plant material, including benthic algae and phytoplankton.	Topsmelt(W)	
Pelagic diet with benthic herbivory	Diet includes largely pelagic invertebrates and benthic algae. This includes a substantial component of benthic algae and attached plants, likely as floating detritus. These benthic plants constitute a potential dietary association with sediment.	Striped mullet(F)	

APPENDIX A-7: LIST OF CHEMICAL ANALYTES FOR SEDIMENT, TISSUE, AND WATER SAMPLES NEEDED TO CHARACTERIZE SEDIMENT CONTAMINATION EXPOSURE AND EFFECT FOR HUMAN HEALTH.

Chemical Name	Chemical Group	Chemical Name	Chemical Group
Total Organic Carbon[1]	General	PCB 095	PCB congener
Percent lipids[2]	General	PCB 097	PCB congener
		PCB 099	PCB congener
alpha Chlordane	Pesticide	PCB 101	PCB congener
gamma Chlordane	Pesticide	PCB 105	PCB congener
cis-Nonachlor	Pesticide	PCB 110	PCB congener
trans-Nonachlor	Pesticide	PCB 114	PCB congener
Oxychlordane	Pesticide	PCB 118	PCB congener
		PCB 126	PCB congener
Dieldrin	Pesticide	PCB 128	PCB congener
		PCB 137	PCB congener
o,p'-DDE	Pesticide	PCB 138	PCB congener
o,p'-DDD	Pesticide	PCB 141	PCB congener
o,p'-DDT	Pesticide	PCB 146	PCB congener
p,p'-DDD	Pesticide	PCB 149	PCB congener
p,p'-DDE	Pesticide	PCB 151	PCB congener
p,p'-DDT	Pesticide	PCB 153	PCB congener
		PCB 156	PCB congener
PCB 008	PCB congener	PCB 157	PCB congener
PCB 018	PCB congener	PCB 158	PCB congener
PCB 027	PCB congener	PCB 169	PCB congener
PCB 028	PCB congener	PCB 170	PCB congener
PCB 029	PCB congener	PCB 174	PCB congener
PCB 031	PCB congener	PCB 177	PCB congener
PCB 033	PCB congener	PCB 180	PCB congener
PCB 044	PCB congener	PCB 183	PCB congener
PCB 049	PCB congener	PCB 187	PCB congener
PCB 052	PCB congener	PCB 189	PCB congener
PCB 056	PCB congener	PCB 194	PCB congener
PCB 060	PCB congener	PCB 195	PCB congener
PCB 064	PCB congener	PCB 198~~/199~~	PCB congener
PCB 066	PCB congener	PCB 199	PCB congener
PCB 070	PCB congener	PCB 200	PCB congener
PCB 074	PCB congener	PCB 201	PCB congener
PCB 077	PCB congener	PCB 203	PCB congener
PCB 087	PCB congener	PCB 206	PCB congener
		PCB 209	PCB congener

1. Sediment only
2. Tissue only

APPENDIX A-8: BIOACCUMULATION MODEL COMPONENTS

Bioaccumulation Model Equations

This assessment framework employs the Arnot and Gobas food web model (2004), modified by Gobas and Arnot (2010), to calculate the biota-sediment accumulation factors (BSAFs) for each of the fish guild species. This is a mechanistic bioaccumulation model which has limited complexity to increase ease of application while accurately depicting the primary bioaccumulation processes (Burkhard 1998, Arnot and Gobas 2004). The Arnot and Gobas model is structured to depict contaminant concentration in biota as the mass balance of key uptake and loss processes. The model equation structure accounts for uptake by diet and respiration; loss by egestion, metabolism, and respiratory elimination; and growth dilution:

Biota Concentration (C_{Biota})=
(Respiratory Uptake*Water Concentration+ Dietary Uptake*Prey Concentration) /
(Elimination + Fecal Egestion + Growth + Metabolism)

The model equations presented here are used to calculate biota concentration and BSAF for each model species. All model equations and assumptions have been presented in detail elsewhere (Gobas 1993, Arnot and Gobas 2004, Gobas and Arnot 2005, Gobas and Arnot 2010).

A few minor modifications were made to the Gobas and Arnot model equations for this framework. The first change was to modify the list of PCB congeners to match multiple California regional monitoring programs, as well as the addition of three classes of chlorinated pesticides: chlordanes, dieldrin, and DDTs. The second modification consists of basing temperature and salinity corrected K_{OW} values for each congener on site-specific measurements. Finally, the food-web structure was modified to be more inclusive of the diverse types of sportfish. This included the addition of several sportfish, including the California halibut, spotted sand bass, queenfish, common carp, topsmelt, and striped mullet. Appropriate prey items were also added such as macrophytes and the decapod crab.

This appendix depicts all equations included in the model. Abiotic input parameters and calculations describe key abiotic processes, such as contaminant partitioning between sediment and the water column, and between dissolved and particulate form. This is followed by biotic input parameters and calculations, which are organized separately for primary producers (phytoplankton and macrophytes) and animals (prey organisms and seafood). The primary producer calculations describe net uptake from the water column into phytoplankton and macrophytes at the base of the food web. The animal calculations are performed for each animal taxa, resulting in food web uptake, and ultimately bioaccumulation in the modeled seafood organisms. The model uses a food web structure and dietary proportions specific for each organism (Tables A-8.1 and A-8.2). For each organism, calculations are performed on a congener-specific basis and later summed to provide total contaminant concentration and BSAF values (i.e., total DDTs).

Table A-8.1. Invertebrate food-web properties. Values indicate the proportion of each diet component.

		P	M	I1	I2	I3	I4	I5	I6	I7	I8	I9
Diet component	S	---	---	---	0.9	0.9	0.3	0.15	0.1	0.3	0.44	---
	P	---	---	1	0.05	0.05	0.35	0.65	0.45	0.65	0.01	0.3
	M	---	---	---	---	---	---	---	---	---	0.1	---
	I1	---	---	---	0.05	0.05	0.35	0.2	0.45	0.05	0.1	0.3
	I2	---	---	---	---	---	---	---	---	---	---	---
	I3	---	---	---	---	---	---	---	---	---	---	---
	I4	---	---	---	---	---	---	---	---	---	0.2	---
	I5	---	---	---	---	---	---	---	---	---	0.15	---
	I6	---	---	---	---	---	---	---	---	---	---	0.4
	I7	---	---	---	---	---	---	---	---	---	---	---
	I8	---	---	---	---	---	---	---	---	---	---	---
	I9	---	---	---	---	---	---	---	---	---	---	---
	F1	---	---	---	---	---	---	---	---	---	---	---
	F2	---	---	---	---	---	---	---	---	---	---	---
	F3	---	---	---	---	---	---	---	---	---	---	---
	F4	---	---	---	---	---	---	---	---	---	---	---
	F5	---	---	---	---	---	---	---	---	---	---	---
	F6	---	---	---	---	---	---	---	---	---	---	---
Physical properties	PW Respir. (mp)	0	0	0	0.05	0.05	0	0	0	0.05	0.05	0
	Lipid (%)	0.12	0.38	1.00	0.75	0.75	1.00	1.00	1.00	0.86	1.25	2.00
	Mass (kg)	---	---	7.10E-08	1.00E-07	1.10E-04	3.13E-06	5.00E-06	1.50E-05	1.12E-02	5.00E-03	3.72E-04

S-sediment
P-phytoplankton
M-macrophytes
I1-zooplankton
I2-small polychaete
I3-large polychaete
I4-amphipod
I5-cumacean
I6-mysid
I7-bivalve mollusk
I8-decapod crab
I9-crangon shrimp
F1-forage fish-herbivore (juvenile jacksmelt)
F2-forage fish-planktivore (northern anchovy)
F3-forage fish-primarily benthivore (juvenile white croaker)
F4-forage fish-benthivore (yellowfin goby)
F5-forage fish-mixed diet I (juvenile shiner perch)
F6-forage fish-mixed diet ii (plainfin midshipman)
PW Respir.-porewater respiration proportion

Table A-8.2. Fish food-web properties. Values indicate the proportion of each diet component.

		F1	F2	F3	F4	F5	F6	SP1	SP2a	SP2b	SP3	SP4	SP5	SP6	SP7	SP8
Diet component	S	---	---	0.05	---	0.05	0.05	---	---	---	---	0.05	0.05	0.29	0.05	0.3
	P	0.8	0.2	0.05	---	0.1	---	---	0.01	---	---	---	0.1	0.04	0.2	0.1
	M	---	---	---	---	---	---	---	---	---	---	---	---	0.2	0.2	0.35
	I1	0.2	0.35	0.2	---	0.2	---	---	---	---	---	---	0.1	0.11	0.08	0.1
	I2	---	---	0.15	0.2	0.05	0.05	---	---	---	0.06	0.2	0.1	---	---	---
	I3	---	---	0.15	0.2	0.05	0.1	---	---	---	0.05	0.2	0.1	0.01	0.01	---
	I4	---	0.2	0.1	0.15	0.25	0.15	---	0.01	0.2	0.12	0.2	0.2	0.1	0.4	0.03
	I5	---	0.15	0.1	0.15	0.25	0.15	---	---	---	0.02	0.2	0.2	0	0.01	---
	I6	---	0.1	0.1	---	0.05	0.2	0.01	---	0.06	0.24	0.1	0.15	0.06	0.05	0.02
	I7	---	---	---	---	---	---	---	0.28	0.08	---	---	---	0.14	---	0.1
	I8	---	---	---	---	---	---	---	0.35	0.11	---	---	---	0.04	---	---
	I9	---	---	0.1	0.25	---	0.2	0.01	---	---	0.03	0.05	---	---	---	---
	F1	---	---	---	---	---	---	0.08	---	---	---	---	---	---	---	---
	F2	---	---	---	---	---	0.05	0.45	0.1	---	0.48	---	---	---	---	---
	F3	---	---	---	---	---	---	0.25	---	---	---	---	---	---	---	---
	F4	---	---	---	---	---	---	0.1	0.15	0.25	---	---	---	0.01	---	---
	F5	---	---	---	0.05	---	0.05		---	0.3	---	---	---	---	---	---
	F6	---	---	---	---	---	---	0.1	0.1	---	---	---	---	---	---	---
Physical properties	PW Respir (mp)	0	0	0	0	0	0.05	0	0	0	0	0	0	0	0	0
	Lipid (%)	1.20	2.50	1.80	3.00	2.00	3.00	m	m	m	m	m	m	m	m	m
	Mass (kg)	4.00E-03	2.15E-02	1.50E-02	3.00E-02	1.31E-03	1.30E-01	1.46	0.60	1.00	0.05	0.37	0.05	2.00	0.02	1.23

S-sediment
P-phytoplankton
M-macrophytes
I1-zooplankton
I2-small polychaete
I3-large polychaete
I4-amphipod
I5-cumacean
I6-mysid
I7-bivalve mollusk
I8-decapod crab
I9-crangon shrimp
F1-forage fish-herbivore (Juvenile jacksmelt)
F2-forage fish-planktivore (Northern anchovy)
F3-forage fish-primarily benthivore (Juvenile white croaker)
F4-forage fish-benthivore (Yellowfin goby)
F5-forage fish-mixed diet i (Juvenile shiner perch)
F6-forage fish-mixed diet ii (Plainfin midshipman)
SP1-piscivore (California halibut)
SP2-benthic diet with piscivory (a:Spotted sand bass, b:White catfish)
SP3-benthic and pelagic with piscivory (Queenfish)
SP4-benthic without piscivory (White croaker)
SP5-benthic and pelagic without piscivory (Shiner perch)
SP6-benthic with herbivory (Common carp)
SP7-benthic and pelagic with herbivory (Topsmelt)
SP8-pelagic with benthic herbivory (Striped mullet)
PW Respir.-porewater respiration proportion

Model Constants

The Arnot and Gobas model, like other food web models, includes numeric inputs that are site specific and additional numeric inputs that are generic constants. Site specific model inputs (e.g., seafood lipid content, sediment organic carbon, and water quality parameters), are obtained locally and modified in each unique application of the model. In contrast, model constants (Table A-8.3) are standard constants based on physical principles, not locally available or measured. The model utilizes constants assembled by the model authors (Arnot and Gobas 2004, Gobas and Arnot 2010) based on fitting model equations to datasets developed in global literature reviews. An exception is octanol-water partitioning coefficient (K_{OW}) for pesticides and some PCBs, which was not included in prior model documentation. Methods for K_{OW} development are documented below.

Octanol-water partitioning coefficient (K_{OW})

The octanol-water partitioning coefficient governs compound partitioning between tissue lipids versus water, and between sediment and porewater. PCB K_{OW} values used in the assessment framework were obtained from Gobas and Arnot (2005). For those PCBs not evaluated in Gobas and Arnot, K_{OW} values were the median of results combined from five published sources: Li *et al.* (2003), Mackay *et al.* (2000), Beyer *et al.* (2002), Hansen *et al.* (1999), and Hawker and Connell (1988). Pesticide K_{OW} values were taken from Shen and Wania (2005), or Leatherbarrow *et al.* (2006), which compiled K_{OW}s from Mackay *et al.* (2000).

Literature K_{OW}s are generally calculated at temperatures of 25°C, which is higher than many California bays and estuaries. Therefore, PCB K_{OW}s are temperature corrected to correspond to the water body temperature, based on the site-specific data. Following Gobas and Arnot (2005, 2010), and references cited therein, the K_{OW} values were temperature corrected using the following equation (Li *et al.* 2003):

$$\log K_{OW}E_T = \log K_{OW}D_T - \frac{\Delta U_{ow}}{\ln(10) * R} * \left(\frac{1}{E_T} - \frac{1}{D_T}\right)$$

Where:

E_T = the environmental temperature (Kelvin)

D_T = the data collection temperature (Kelvin)

ΔU_{OW} = the internal energy of octanol-water phase transfer

R = the gas law constant (0.0083145 kJ/mol K)

Empirically-derived ΔU_{OW} were unavailable for some congeners, and were estimated to be -28 kJ/mol, the median of empirical ΔU_{OW} data for other PCB congeners, and -25 kJ/mol for the pesticides.

Following Gobas and Arnot (2005, 2010), and references cited therein, K_{OW} values are also salinity corrected to correspond to the measured water body average salinity. Salinity corrections followed Xie *et al.*(1997):

$$K_{OW}S = K_{OW}T \times 10^{(SPC \cdot Vh \cdot MCS \cdot Sal / 35)}$$

Where:

SPC = the Setschenow proportionality constant (0.0018 L/cm^3)

Vh = the LeBas molar volume (cm^3/mol) of the chemical (calculated following Tucker and Nelken 1982)

MCS = the molar concentration of seawater at 35 practical salinity units (0.5)

Sal = the salinity for the system of interest (psu)

Summary tables of the PCB and pesticide physical-chemical parameters (Vh, ΔU_{OW}, and $LogK_{OW}$ values) are listed in tables A-8.4 and A-8.5, respectively.

Table A-8.3. Constant values used for bioaccumulation model calculations.

Bioaccumulation Parameters and Constants	**Parameter Name**	**Value**	**Units**
Density of lipid	dLipid	0.9	kg/L
Disequilibrium factor for particulate organic carbon (POC) partitioning	dPOC	1	unitless
Disequilibrium factor for dissolved organic carbon (DOC) partitioning	dDOC	1	unitless
Proportionality constant describing phase partitioning of POC	alphaPOC	0.35	unitless
Proportionality constant describing phase partitioning of DOC	alphaDOC	0.08	unitless
Non-lipid organic carbon (NLOC) proportionality constant	lipcf	0.35	unitless
Non-lipid organic matter (NLOM) proportionality constant	lipcfp	0.035	unitless
NLOC for plants	NLOC	6.00	%
NLOM for animals	NLOM	20.00	%
NLOM for bivalves	NLOM/2	10.00	%
Metabolic rate constant	kM	0	1/day
Constant for phytoplankton aqueous uptake rate	pA	6.0E-5	1/day
Constant for phytoplankton aqueous uptake rate	pB	5.5	1/day
Growth rate for phytoplankton	kGp	0.080	1/day
Growth rate for macrophytes	kGm	0.125	1/day
Invertebrate Growth Rate Coefficient	IGR	3.5E-4	unitless
Fish Growth Rate Coefficient	FGR	7E-4	unitless
Particle scavenging efficiency for filter feeders	scav	100	%
Invertebrate Lipid Digestion Efficiency (alpha)	alphaI	0.75	Unitless
Invertebrate NLOM Digestion Efficiency (beta)	betaI	0.75	unitless
Invertebrate Water Digestion Efficiency (chi)	chiI	0.55	unitless
Zooplankton Lipid Digestion Efficiency (alpha)	alphaZ	0.75~~2~~	unitless
Zooplankton NLOM Digestion Efficiency (beta)	betaZ	0.75~~2~~	unitless
Zooplankton Water Digestion Efficiency (chi)	chiZ	0.55	unitless
Fish Lipid Digestion Efficiency (alpha)	alphaF	0.92	unitless
Fish NLOM Digestion Efficiency (beta)	betaF	0.6~~5~~	unitless
Fish Water Digestion Efficiency (chi)	chiF	0.55	unitless
Ed - Constant A - Invertebrates and Fish	A	8.50E-8	Unitless
Ed - Constant B - Invertebrates and Fish	B	2	unitless

Table A-8.4. PCB congener list with physical-chemical property values.

PCB Congener	**LeBas molar volume (Mackay 2006)**	**ΔUow at 25 °C (kJ/mol)**	**Log K_{OW} at 25 °C**
PCB 8	226.4	-22.7	5.12
PCB 11*	226.4	-28	5.27
PCB 18	247.3	-25	5.3
PCB 27	247.3	-28	5.4
PCB 28	247.3	-26.3	5.66
PCB 29	247.3	-28	5.6
PCB 31	247.3	-25.9	5.78
PCB 33	247.3	-26	5.65
PCB 37*	247.3	-28	5.78
PCB 44	268.2	-26	5.82
PCB 49	268.2	-27	5.95
PCB 52	268.2	-27.3	5.91
PCB 56	268.2	-30	6.02
PCB 60	268.2	-30	6.12
PCB 64	268.2	-28	5.79
PCB 66	268.2	-28	6.01
PCB 70	268.2	-28	6.1
PCB 74	268.2	-28	6.11
PCB 77	268.2	-28	6.26
PCB 81*	268.2	-28	6.25
PCB 87	289.1	-28	6.35
PCB 95	289.1	-28	6.06
PCB 97	289.1	-28	6.27
PCB 99	289.1	-28	6.36
PCB 101	289.1	-23.8	6.33
PCB 105	289.1	-28.6	6.82
PCB 110	289.1	-28	6.31
PCB 114	289.1	-28	6.65
PCB 118	289.1	-28.5	6.69
PCB 119*	289.1	-28	6.4
PCB 123*	289.1	-28	6.64
PCB 126	289.1	-28	6.77
PCB 128	310	-28	6.79
PCB 132*	310	-25	6.54
PCB 137	310	-28	6.83
PCB 138	310	-25	7.22
PCB 141	310	-25	6.77
PCB 146	310	-28	6.87

Table A-8.4. Continued

PCB Congener	LeBas molar volume (Mackay 2006)	ΔUow at 25 °C (kJ/mol)	Log Kow at 25 °C
PCB 149	310	-25	6.62
PCB 151	310	-25	6.6
PCB 153	310	-31.1	6.87
PCB 156	310	-23	7.01
PCB 157	310	-28	7.18
PCB 158	310	-23	6.87
PCB 167*	310	-28	7.28
PCB 168*	310	-28	7.11
PCB 169	310	-28	7.42
PCB 170	330.9	-25	7.18
PCB 174	330.9	-28	7.03
PCB 177	330.9	-28	7.01
PCB 180	330.9	-29.1	7.16
PCB 183	330.9	-28	7.12
PCB 187	330.9	-28	7.09
PCB 189	330.9	-28	7.3
PCB 194	351.8	-28	7.76
PCB 195	351.8	-28	7.45
PCB 198	351.8	-28	7.43
PCB 199	351.8	-28	7.2
PCB 200	351.8	-28	7.27
PCB 201	351.8	-28	7.51
PCB 203	351.8	-28	7.53
PCB 206	372.7	-28	7.8
PCB 209	393.6	-28	8.18

*Optional, not required (See Appendix A-7)

Table A-8.5. Pesticide congener list with physical-chemical property values.

PCB Congener	LeBas molar volume (Mackay 2006)	ΔUow at 25 °C (kJ/mol)	Log Kow at 25 °C
cis-Chlordane	340.5	-25	6.20
trans-Chlordane	340.5	-25	6.27
cis-Nonachlor	361.4	-25	5.70
trans-Nonachlor	361.4	-25	5.70
Oxychlordane	250	-25	2.60
Dieldrin	332.2	-25	5.48
op-DDD	312.6	-25	5.34
op-DDE	305.2	-25	5.63
op-DDT	333.5	-25	5.70
pp-DDD	312.6	-25	6.33
pp-DDE	305.2	-25	6.93
pp-DDT	333.5	-25	6.39

Abiotic site-specific input parameters

TOC = organic carbon proportion in sediment (%)

DOCw = DOC concentration in H_2O (kg/L)

POCw = POC concentration in H_2O (kg/L)

T = mean water temperature (°C)

Sal = water salinity (PSU)

DO = dissolved oxygen concentration (mg O_2/L)

SSC = concentration of suspended solids (kg/L)

Congener-specific abiotic parameters

$K_{OW}T$ = octanol-water partitioning coefficient (temperature corrected)

$K_{OW}S$ = octanol-water partitioning coefficient (corrected for temperature and salinity)

K_{OC} = octanol-organic carbon partitioning coefficient (uses the $K_{OW}S$ value)

csed = contaminant concentration in sediment (ng/g dry weight)

cpw = dissolved contaminant concentration in porewater (ng/mL)

cwatD = dissolved contaminant concentration in surface water (ng/mL)

cwat = total contaminant concentration in surface water (ng/mL)

phi = ratio of dissolved contaminant concentration to total contaminant concentration in surface water (unitless)

Congener-specific abiotic calculations

$logK_{OW}T = logK_{OW}D_T - \frac{\Delta U_{ow}}{\ln(10)*R} * \left(\frac{1}{T} - \frac{1}{D_T}\right)$

Where:

$logK_{OW}D_T$ = $logK_{OW}$ at 25 °C or 298K in Tables A-8.4 and A-8.5.

$logK_{OW}T$ = temperature corrected $logK_{OW}$ at the site-specific temperature (T)

$K_{OW}S = K_{OW}T \times 10^{(SPC \cdot Vh \cdot MCS \cdot Sal / 35)}$

$K_{OC} = 0.35*K_{OW}S$

cpw = csed/(TOC*K_{OC})

cwatD = measured dissolved water concentration or estimated from total concentration as:

cwatD = phi*cwat

phi = 1/(1 + POCw*dPOC*alphapoc*$K_{OW}S$ + DOCw*dDOC*alphadoc*$K_{OW}S$)

The model compares measured surface water concentration to that estimated from site sediment concentration in order to minimize the influence of off-site sources on bioaccumulation. This estimation is based on the organic carbon partitioning used in the calculation of porewater concentration. Empirical data were used to determine the relationship between calculated porewater concentrations and measured dissolved surface water concentrations of the contaminants used in the model. This resulted in a median dilution factor of eight, as presented in the equation below:

Estimated cwatD = csed/(TOC*K_{OC}*8)

The lowest value (measured or estimated) for each congener is used as cwatD in the model calculations.

Organism-specific parameters

Wb = body weight (kg)

Gv = gill ventilation rate (L/day)

lipid = tissue lipid content (%)

wc = tissue water content (kg water/kg organism ww)= 1-lipid-NLOM (animals), 1-lipid-NLOC (phytoplankton and macrophytes), 1-lipid-(NLOM/2) (bivalves)

Gd = feeding rate (kg food/day)

kG = organism growth rate (1/day)

vld = proportion of diet that is lipid (calculated based on diet proportion of prey and prey lipid content, unitless)

vcd = proportion of diet that is non-lipid organic carbon (calculated based on diet proportion of prey and prey NLOC content, unitless)

vnd = proportion of diet that is non-lipid organic matter (calculated based on diet proportion of prey and prey NLOM content, unitless)

vwd = proportion of diet that is water (calculated based on diet proportion of prey and prey water content, unitless)

vlg = lipid fraction of gut (kg lipid/kg organism ww)

vcg = NLOC fraction of gut (kg NLOC/kg organism ww)

vng = NLOM fraction of gut (kg NLOM/kg organism ww)

vwg = water fraction of gut (kg water/kg organism ww)

mp = proportion of respiration or transpiration due to porewater (Tables A-8.1 and A-8.2, unitless)

mo = proportion of respiration or transpiration due to overlying water column (unitless)

Contaminant-specific model variables

Ew = contaminant-specific gill chemical uptake efficiency (unitless)

Ed = contaminant-specific dietary chemical transfer efficiency (also called gut uptake efficiency, unitless)

k1 = aqueous uptake rate constant (L/kg·day)

kbw = biota-water partition coefficient (i.e., bioconcentration factor, L/kg organism ww)

k2 = elimination rate constant (1/day)

kd = dietary uptake rate constant (kg food/kg organism·day)kG = growth rate (1/day)

Gf = fecal egestion rate (kg feces/kg organism·day)

kgb = gut-biota partition coefficient (unitless)

ke = fecal egestion rate constant (1/day)

p_i = proportion of diet by mass that is prey item i (unitless)

p_S = proportion of diet by mass that is sediment (unitless)

cD = contaminant concentration in diet (weighted average across all prey items, ng/g ww)

$cbiota_i$ = contaminant concentration in biota organism i (ng/g organism ww)

BSAF = biota-sediment accumulation factor (unitless)

Calculations for phytoplankton and aquatic macrophytes

$k1 = 1/(pA + pB/K_{OW}S)$

$kbw = (lipid*K_{OW}S/dLipid + nloc*lipcf*K_{OW}S + wc)$

$k2 = k1/kbw$

$cbiota=k1*(cwatD)/ (k2 + kGp^*)$ [*kGp for phytoplankton and kGm for macrophyte]

BSAF = cbiota/csed

Calculations for animals (prey organisms and seafood)

$Ew = 1/(1.85+155/K_{OW}S)$

$Ed = 1/(A*K_{OW}T + B)$

$Gv = (1400*Wb^{0.65})/DO$

$k1 = Ew*Gv/Wb$

$kbw = K_{OW}S *(lipid/dLipid + nlom*lipcfp) + wc$

$k2 = k1/kbw$

$Gd = 0.022 * (Wb^{0.85}) * e^{0.06*T}$ [For fish and nonfilter feeding invertebrates]

$Gd = Gv*SSC*scav$ [For filter feeding invertebrates]

kd = Ed*Gd/Wb

$kG = IGR * Wb^{-0.2}$ [For invertebrates]

$kG = FGR * Wb^{-0.2}$ [For fishes]

vld= $\sum_{i=1}^{n} p_i * lipid_i$; vcd= $\sum_{i=1}^{n} p_i * nloc_i$; vnd= $\sum_{i=1}^{n} p_i * nlom_i$; vwd= $\sum_{i=1}^{n} p_i * water_i$

where i = [1…n] represent individual prey taxa

Gf=Gd*((1-alpha)*vld+ (1-beta)*(vcd + vnd)+ (1-chi)*vwd)

vlg= (1-alpha)*vld/ ((1-alpha)*vld+ (1-beta)*(vcd + vnd)+ (1-chi)*vwd)

vcg= (1-beta)*vcd/ ((1-alpha)*vld+ (1-beta)*(vcd + vnd)+ (1-chi)*vwd)

vng= (1-beta)*vnd/ ((1-alpha)*vld+ (1-beta)*(vcd + vnd)+ (1-chi)*vwd)

vwg= (1-chi)*vwd/ ((1-alpha)*vld+ (1-beta)*(vcd + vnd)+ (1-chi)*vwd)

kgb=((vlg/dLipid + vng*lipcf + vcg*lipcfp)*K_{OW}T + vwg)/ ((lipid/dLipid + nlom*lipcfp)*K_{OW}T + wc)

ke = Gf*Ed*kgb/Wb

mo = 1 – mp

cD = $p_s * csed + \sum_{i=1}^{n} p_i * cbiota_i$

where i = [1…n] represent individual prey taxa

cbiota = (k1*(mo*cwatD + mp*cpw)+ kd*cD) / (k2 + ke + kG + kM)

BSAF = cbiota/csed

Site Assessment Calculations

Chemical Exposure Evaluation

Calculate the weighted average observed tissue concentration based on the diet proportion for each fish species represented and measured tissue concentration for total chlordanes, ~~total d~~Dieldrin, total DDTs, and total PCBs. Compare this weighted average to the chemical exposure thresholds in Table 16 for Tier 1 evaluation and Table 19 for Tier 2 evaluation.

Site Linkage Determination

In evaluation of the site linkage, Monte-Carlo Simulation (MCS) is used to incorporate the variability of both the measured sediment and tissue concentrations, the fish guild home range (HR), and the estimated BSAF values. For this analysis, a lognormal distribution is used for BSAF and sediment concentrations, and the appropriate distributions for each home range is indicated in Table A-8.6. A total of 10,000 iterations should be used for the simulation.

Site linkage = C_{Est}/C_{Tis}

C_{Est} = weighted average estimated tissue concentration based on the proportion of the human diet for each guild (ng/g).

Calculate the average estimated tissue concentration for each guild, i, and contaminant class (i.e., total DDTs) using the following equation:

$C_{Est,i} = \Sigma C_{Sed} \times SUF_i \times BSAF_i$

ΣC_{Sed} = lognormal distribution of sediment concentration using the measured mean and standard error

SUF_i = site use factor for species i = SA/HR_i. SA is the area or length of site depending on the basis of the HR. HR distribution is calculated using the HR mean and HR standard deviation (SD) listed ~~as found~~ in Table A~~C~~-8.6. If the calculated SUF is less than 1, use the calculated value. If the SUF is equal to or greater than 1, use the value of 1.

$BSAF_i$ = lognormal distribution of the mean BSAF for guild, i, from the model prediction and the calculated BSAF SD.

BSAF SD = CVBSAF*BSAF

CVBSAF = 0.782

The CVBSAF was estimated from empirical data using the following equations:

$$SD = \sqrt{(m^2)(e^{\sigma^2} - 1)}$$

$$CV = \frac{\sqrt{(m^2)(e^{\sigma^2} - 1)}}{m} = \sqrt{(e^{\sigma^2} - 1)}$$

Where σ = lognormal standard deviation

m = mean (this value cancels out)

CV = coefficient of variation

C_{Tis} = weighted average observed tissue concentration

Use a lognormal distribution for measured mean tissue data and standard error for each guild for total chlordanes, total dieldrin, total DDTs, and total PCBs.

Calculate the weighted average for each contaminant class based on the proportion of the human diet for each guild (ng/g).

Table A-8.6. Home range parameters for each sportfish guild.

Species	**Guild**	**HR Basis**	**HR Mean**	**HR SD**	**HR Distribution**
California halibut	Piscivore	Site length (km)	29.3	60	Lognormal distribution
Spotted sand bass	Benthic diet with piscivory	Site area (km^2)	0.0071	0.0073	Lognormal distribution
White Catfish	Benthic diet with piscivory	Site length (km)	6.9	9.6	Lognormal distribution
Queenfish	Benthic and pelagic with piscivory	Site area (km^2)	3	4.689	Lognormal distribution
White croaker	Benthic without piscivory	Site area (km^2)	3	4.689	Lognormal distribution
Shiner perch	Benthic and pelagic without piscivory	Site area (km^2)	0.0012	0.000804	Lognormal distribution
Common carp	Benthic with herbivory	Site length*1000 (km)	1.05	9904	Inverse gamma cumulative distribution*
Topsmelt	Benthic and pelagic with herbivory	Site area (km^2)	0.0012	0.000804	Lognormal distribution
Striped mullet	Pelagic with benthic herbivory	Site length (km)	28.2	80.34	Lognormal distribution

HR mean = mean home range of seafood species under consideration (km or km^2, depending on taxa).

HR SD = standard deviation of home range of seafood species

*Inverse gamma cumulative distribution requires 3 terms:

Probability= a random number uniformly distributed over $0 \le x < 1$

Alpha= HR mean value (shape parameter)

Beta= HR SD value (scale parameter)

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