CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN DIEGO REGION

GUIDELINES FOR ASSESSMENT AND REMEDIATION
OF
CONTAMINATED SEDIMENTS IN SAN DIEGO BAY AT
NASSCO AND SOUTHWEST MARINE SHIPYARDS

June 1, 2001

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APPENDICES LIST

LIST OF ACRONYMS AND ABBREVIATIONS

AET	Apparent Effects Threshold
AQUA	Aquaculture Beneficial Use
AVS/SEM	Acid Volatile Sulfide / Simultaneously Extracted Metals
Bight 98	Southern California Bight 1998 Regional Marine Monitoring Survey
BIOL	Preservation of Biological Habitats of Special Significance
BSAFs	Biota-to-Sediment Accumulation Factors
CTR	California Toxics Rule
COMM	Commercial and Sport Fishing Beneficial Use
EC_{50}	Median Effective Concentration
EqP	Equilibrium Partitioning Approach
EST	Estuarine Habitat Beneficial Use
Kp	Partition Coefficients
LAET	Lowest Apparent Effects Threshold
LC_{50}	Median Lethal Concentration
MAR	Marine Habitat Beneficial Use
MIGR	Migration of Aquatic Organisms Beneficial Use
NAV	Navigation Beneficial Use
NASSCO	National Steel and Shipbuilding Company
OHHEA	Office of Environmental Health and Hazard Assessment
PAHs	Polynuclear Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PCTs	Polychlorinated Triphenyls
RARE	Rare, Threatened or Endangered Species Beneficial Use
REC1	Contact Water Recreation Beneficial Use
REC2	Non Contact Water Recreation Beneficial Use
REF-03	Reference Station 3
SCCWRP	Southern California Coastal Water Research Project
SHELL	Shellfish Harvesting Beneficial Use
SPWN	Spawning Habitat Beneficial Use
SSDTT	Sediment Serial Dilution Toxicity Test
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TR	Tissue Residue (biota-water-sediment equilibrium partitioning approach)
TRGs	Tissue Residue Guidelines
Triad Approach	Sediment Quality Triad Approach
WILD	Wildlife Habitat Beneficial Use

DEFINITIONS

Acute Toxicity - The immediate or short-term response of an organism to a chemical substance. Lethality is the response that is most commonly measured in acute toxicity tests.

Benthic Invertebrate Community – The assemblage of various species of sediment dwelling organisms that are found within an aquatic ecosystem.

Bioaccumulation – The net accumulation of a chemical substance by an organism as a result of uptake from all environmental sources.

Bioaccumulative Substances – The chemicals that tend to accumulate in the tissues of aquatic organisms.

Bioavailability - The fraction of a chemical present in the sediment that is available for uptake by organisms

Bulk Sediment – Sediment and associated porewater.

Chronic Toxicity – The response of an organism to long-term exposure to a chemical substance. Among others, the responses that are typically measured in chronic toxicity tests include lethality, decreased growth and impaired reproduction.

EC_{50} - Concentration of a toxicant predicted to cause a sublethal effect in 50% of test organisms over the course of an exposure period.

Endpoint – The response measured in a toxicity test.

LC_{50} – Concentration of a toxicant predicted to cause a lethal effect in 50% of test organisms over the course of an exposure period.

Porewater – The water that occupies the spaces between sediment particles.

Sediment – Particulate material that usually lies below water.

Toxicity Test - A laboratory experiment that measure the response (e.g., survival, growth, or reproduction) of an organism following exposure to a sample suspected of containing harmful substances.

Wildlife – The reptiles, amphibians, birds, and mammals that are associated with aquatic ecosystems [e.g., piscivorous (fish eating) wildlife].

I INTRODUCTION

Elevated levels of pollutants exist in the bay bottom sediments adjacent to NASSCO and Southwest Marine shipyards. The concentrations of these pollutants cause or threaten to cause a condition of pollution that harms aquatic life beneficial uses designated for San Diego Bay. The concentrations of these pollutants may also present aquatic-dependent wildlife and human health risks from exposure to pollutants through the food chain attributable to the contaminated sediment.

The purpose of this document is to provide guidelines for the assessment and remediation of contaminated sediments in San Diego Bay at NASSCO and Southwest Marine shipyards. The Regional Board is requiring NASSCO and Southwest Marine shipyards to perform an investigation to determine: (1) The nature and extent of the waste discharges, (2) The biological effects and human health risk associated with bay sediments containing pollutants resulting from the discharges, and (3) Appropriate cleanup and abatement measures.

II REGIONAL BOARD MANDATE

The Regional Board designates cleanup levels for contaminated bay sediment sites in accordance with the enclosed State Water Resources Control Board Resolution No. 92-49, POLICIES AND PROCEDURES FOR INVESTIGATION AND CLEANUP AND ABATEMENT OF DISCHARGES UNDER WATER CODE SECTION 13304. Resolution No. 92-49 is a state policy that establishes policies and procedures for investigation and cleanup and abatement under Water Code Section 13304. The Resolution establishes the basis for determining cleanup levels of waters of the State and sediments that impact waters of the State.

Resolution No. 92-49 provides that dischargers are required to cleanup and abate the effects of discharges….. “in a manner that promotes attainment of either background water quality, or the best water quality which is reasonable if background levels of water quality cannot be restored...”. Alternative cleanup levels less stringent than background must, among other things, not unreasonably affect present and anticipated beneficial uses of waters of the State. The Resolution also includes procedures to investigate the nature and horizontal and vertical extent of a discharge and procedures to determine appropriate cleanup and abatement measures.

III PRESUMPTIVE CLEANUP GOAL

Under the terms of Resolution No. 92-49, the Regional Board is obligated to have a presumptive cleanup goal to require cleanup to attain background water quality conditions. The Regional Board will establish a cleanup level above background water quality conditions, only if the Board determines that it is technologically or economically infeasible to achieve background water quality conditions. If the Regional Board makes such a determination, the Board will then select a cleanup level that is based on the lowest levels which are technologically or economically

achievable and that will not unreasonably affect present and anticipated beneficial uses of waters of the Region. This approach provides for determining and establishing a level of water quality protection which is reasonable without allowing or causing an unreasonable effect on water quality.

IV BENEFICIAL USES TO BE PROTECTED

The Basin Plan designates 12 beneficial uses for San Diego Bay that may be adversely affected by the contaminated sediment. Contaminated bay bottom sediments may adversely affect eleven of the beneficial uses. These beneficial uses fall into four broad categories as shown below:

AQUATIC LIFE BENEFICAL USES	AQUATIC -DEPENDENT WILDLIFE BENEFICAL USES	HUMAN HEALTH BENEFICIAL USE	NAVIGATION AND SHIPPING BENEFICICAL USES
Estuarine Habitat (EST)	Wildlife Habitat (WILD)	Contact Water Recreation (REC1)	Navigation (NAV)
Marine Habitat (MAR)	Preservation of Biological Habitats of Special Significance (BIOL)	Non Contact Water Recreation (REC2)	
Migration of Aquatic Organisms (MIGR)	Rare, Threatened or Endangered Species (RARE)	Shellfish Harvesting (SHELL)	
Preservation of Biological Habitats of Special Significance (BIOL)		Commercial and Sport Fishing (COMM)	

The environmental threat associated with contaminated sediments is caused by the tendency of many chemical substances discharged into marine waters to attach to sediment particles and thus accumulate to high concentrations in the bay bottom sediments. The bottom sediments support biological communities of benthic or bottom dwelling organisms, (e.g., worms, clams, bottom feeding fish), that live in and eat marine sediment. The marine sediments may also serve as a spawning habitat for many pelagic species that inhabit the water column (e.g., invertebrates and fish). The elevated concentrations of chemicals in the sediment may cause acute mortality or can affect the reproductive behavior, egg hatching characteristics, and the early life development of these organisms. In addition to acute mortality and abnormal development phenomena, contaminated sediments can also lead to the accumulation of contaminants in organisms due to the effects of bioaccumulation. In addition, biomagnification of the contaminants can occur in the food chain when smaller contaminated organisms are consumed by higher trophic level species, including humans. The primary and by far the most significant threat to the public health are the consumption of fish and shellfish contaminated by chemicals in the sediment.

Shipping, travel or transportation by private, military or commercial vessels is an

important beneficial use in San Diego Bay. The protection of this beneficial use is dependent upon maintaining appropriate depths in shipping channels and vessel berthing areas by carrying out maintenance dredging. The Navigation (NAV) beneficial use can be adversely affected when maintenance-dredging projects are stymied due to water quality problems associated with the resuspension and migration of contaminants from contaminated bay sediments to previously uncontaminated areas. The Navigation beneficial use can also be affected when contaminants in bay sediments complicate the disposal of dredged sediment by exceeding criteria for the ocean disposal of dredged sediment or the beneficial reuse of dredged sediment (e.g. beach replenishment) from maintenance dredging projects.

NASSCO's and Southwest Marine's investigation must address the development of cleanup levels to protect the aquatic life, aquatic-dependent wildlife, human health and navigation and shipping categories of beneficial uses. The Regional Board is making the assumption that: (1) The benthic community (covered under the marine habitat beneficial use), (2) Aquatic-dependent wildlife (e.g., birds, mammals, and reptiles) consumption of fish and other aquatic organisms (covered under the Wildlife Habitat beneficial use), and (3) The human consumption of fish and shellfish (covered under the Commercial and Sport Fishing and Shellfish Harvesting beneficial uses) represent the most sensitive beneficial uses needing protection from contaminated sediment at NASSCO and Southwest Marine shipyards.

V SITE REMEDIATION CLEANUP GOALS

The Regional Board is mandated under Resolution 92-49 to require cleanup to either: (1) Attain sediment chemistry background conditions, or (2) if background conditions cannot be achieved , attain sediment chemistry conditions as close to background as possible that will protect beneficial uses. There are three categories of beneficial uses requiring protection: aquatic life beneficial uses, aquatic-dependent wildlife beneficial uses, and human health beneficial uses.

Accordingly four broad investigations are required to develop: (1) Cleanup levels to attain background conditions or as close to background conditions as possible; (2) Cleanup levels to protect aquatic life beneficial uses; (3) Cleanup levels to protect aquatic-dependent wildlife beneficial uses; and (4) Cleanup levels to protect human health. The work activities required and the associated sequence of these work activities are illustrated in the following figures in Appendix A :

- Figure 1 - NASSCO & Southwest Marine Shipyards Cleanup Level Methodology Selection
- Figure 2 - Sediment Cleanup Levels to Protect Aquatic Life
- Figure 3 - Sediment Cleanup Levels to Protect Aquatic-Dependent Wildlife
- Figure 4 - Sediment Cleanup Levels to Protect Human Health.

VI SITE REMEDIATION WORKPLAN

A. NASSCO and Southwest Marine shipyards shall develop and submit to

the Regional Board by June 25, 2001, a workplan and time schedule for development of the site assessment, sediment cleanup levels, sediment cleanup alternatives, and cleanup costs associated with the following: (1) Sediment cleanup levels to attain background conditions or as close to background conditions as possible; (2) Sediment cleanup levels to protect aquatic life beneficial uses; (3) Sediment cleanup levels to protect aquatic-dependent wildlife beneficial uses; and (4) Sediment cleanup levels to protect human health. The workplan shall conform to the guidelines contained in this document and be subject to the approval of the Regional Board Executive Officer.

B. The workplan shall contain the following main elements describing the work to be done in conformance with the guidelines contained in this document.

1. *Spatial Site Assessment*: The workplan shall include a detailed description of the study design to define and analyze the extent and magnitude of sediment contaminants and associated biological effects related to shipbuilding and repair activities.

2. *Spatial Data Analysis*: The workplan shall include a conceptual framework for assessing sediment quality and the potential for impairment of aquatic life, aquatic-dependent wildlife, and human health beneficial uses. Additionally, the workplan shall include a detailed description of the maps that will be developed to depict the areas where there is a potential for beneficial use impairment.

3. *Numerical Data Analysis to Determine Sediment Cleanup Levels*: The workplan shall provide a description of the methodologies to be used for developing sediment cleanup levels to protect aquatic life, aquatic-dependent wildlife, and human health beneficial uses. Additionally, the workplan shall provide a detailed description of the maps that will be developed to depict the areas exceeding the sediment cleanup levels.

4. *Cleanup Alternatives Analyses*: The workplan shall include a description of the methodologies to be used for developing technological and economic feasibility analyses for each of the sediment cleanup levels and applicable cleanup methodologies, including an evaluation of the potential benefits and adverse effects associated with each strategy.

5. *Selection of Target Cleanup Level*: The workplan shall include a description of the methodologies to be used for selection of the final cleanup level. If the final recommended cleanup level does not attain background levels, the final report must include justification for an alternative cleanup level which is as close to background as possible based on the technological and economic feasibility

analyses for each of the cleanup levels and cleanup methodologies.

6. *Logistics and time schedule:* The workplan shall describe the overall field and laboratory logistics for the site investigation and remediation. The time schedule shall include dates for completing all major tasks in an expedited time frame.

7. *Information Management:* In order to facilitate data sharing, NASSCO and Southwest Marine shipyards shall enter data into a data management system consistent with the standardized data transfer format protocols established by the Southern California Bight 1998 Regional Marine Monitoring Survey (Bight 98) Steering Committee, Southern California Coastal Water Research Project (SCCWRP). Data collected from the project shall be provided to the Regional Board in electronic and paper format.

8. *Quality Assurance and Quality Control:* The Quality Assurance Plan, including field and laboratory methods, shall be modeled on the Quality Assurance Manuals prepared for the Bight 98 Steering Committee, Southern California Coastal Water Research Project. The Quality Assurance Plan shall include provisions for notifying Regional Board staff of sampling activities and provisions for a split-sampling program with the Regional Board.

9. *Project Management:* Each component of the site remediation investigation shall be conducted under the direction of appropriately qualified professionals, licensed where applicable, and competent and proficient in the fields pertinent to the issue of sediment cleanup. A statement of qualifications of the responsible lead professionals shall be included in all plans and reports submitted by NASSCO and Southwest Marine shipyards.

VII **SPATIAL SITE ASSESSMENT**

NASSCO and Southwest Marine shipyards shall define and analyze the extent and magnitude of sediment contaminants and associated biological effects related to shipbuilding and repair activities within and adjacent to their leaseholds. The site assessment shall include sufficient detail and address all necessary factors to develop: (1) Sediment cleanup levels to attain background conditions or as close to background conditions as possible; (2) Sediment cleanup levels to protect aquatic life beneficial uses; (3) Sediment cleanup levels to protect aquatic-dependent wildlife beneficial uses; and (4) Sediment cleanup levels to protect human health beneficial uses.

A. General Spatial Site Assessment Guidelines

1. *Sampling Locations:* NASSCO and Southwest Marine shipyards shall specify the number and locations of sampling stations within and adjacent to the shipyard leaseholds. The station selection shall facilitate producing maps that illustrate areas where there is a potential for beneficial use impairment and facilitate the development of sediment cleanup levels that protect aquatic life, aquatic-dependent wildlife, and human health beneficial uses.

2. *Reference Stations:* NASSCO and Southwest Marine shipyards shall specify the number and location of offsite reference stations to evaluate statistically significant differences between reference conditions and site conditions with respect to sediment chemistry, toxicity, benthic community structure, and bioaccumulation. The reference stations should be representative of current water quality conditions of San Diego Bay, including bay-wide urban anthropogenic sources of pollutants (at concentrations that are nontoxic) and excluding sources of pollutants associated with shipbuilding and repair activities. These sites shall have similar physical characteristics (e.g. grain size, water depth, and total organic carbon [TOC]) as compared to the NASSCO and Southwest Marine shipyard sediment conditions.

3. *Sediment and Pore Water Chemistry:* The list of contaminants to be measured include metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc), butyltin species, polychlorinated biphenyls (PCBs)/ polychlorinated triphenyls (PCTs), polynuclear aromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPH), and any other chemical constituent associated with shipbuilding and repair activities believed to be present in bay sediment.

4. *Pollution Sources:* NASSCO and Southwest Marine shipyards shall determine and describe the sources of pollution, which caused the contaminated sediment to exist. Both shipyard and non-shipyard sources shall be evaluated for current and/or historic activities that may have contributed contaminants to San Diego Bay.

B. Background Conditions Spatial Site Assessment Guidelines

1. NASSCO and Southwest Marine shipyards shall determine the vertical and horizontal extent of sediment contaminants associated with shipbuilding and repair activities that are present in bay sediment in excess of background concentrations, within and adjacent to their leaseholds.

2. For the purposes of this assessment, background sediment chemical concentrations are defined as the current chemical concentrations in the sediment absent the existence of the shipyards (i.e., excluding the pollutant loading by NASSCO and Southwest Marine and considering urban storm water inputs only). The background sediment chemical concentrations are represented by the sediment pollutant concentrations found at Reference Station 3 (REF-03), as described on Page 29 of the February 16, 2001 staff report titled *Final Regional Board Report, Shipyard Sediment Cleanup Levels, NASSCO & Southwest Marine Shipyards, San Diego Bay)*. REF-03 is located on the northeast side of San Diego Bay at the end of Broadway Pier. The background sediment chemical concentrations at REF-03 for the chemicals of concern at NASSCO and Southwest Marine include:

Constituent	Background Reference Station Dry Weight (mg/kg)
Copper	87.5
Zinc	139
Lead	41
PCBs	0.12
Mercury	0.57

3. San Diego Bay water quality chemistry, toxicity and biological information will soon be available from Bight 98. Regional Board staff is working with SCCWRP to determine alternate background chemical concentrations for NASSCO and Southwest Marine using the Bight 98 data. Bight 98 sample stations will be identified based on the following criteria: (1) The stations should have similar physical characteristics as the shipyard sediments (e.g., grain size, water depth, and TOC), (2) The sediment is representative of urban watershed loading only, (3) The sediment is representative of non-toxic sediments in San Diego Bay and (4) The sediment contains a healthy benthos. The Regional Board may replace the REF-03 sediment chemical concentrations with the Bight 98 sediment chemical concentrations to define background concentrations at NASSCO and Southwest Marine.

C. Aquatic Life Investigation Spatial Site Assessment Guidelines

1. NASSCO and Southwest Marine shipyards shall specify the number and locations of sampling stations within and adjacent to their leaseholds to determine areas where there is a potential for aquatic life impairment and to facilitate the development of sediment cleanup levels that protect aquatic life (as defined in Section VIII, B. Aquatic Life Cleanup Level Guidelines.

2. The stations shall be assessed using the Sediment Quality Triad

Approach (Triad Approach). The Triad Approach consists of synoptic measures of sediment chemical contamination and biological effects. The three components of the Triad Approach are:

a) Sediment chemistry;

b) Sediment, sediment-water interface, and pore water toxicity (determined through bioassays); and

c) Benthic community structure (determined through taxonomic analyses of macrofauna).

Chemical analyses provide information on the mixtures and concentrations of contaminants in the sediments and pore water that may be harmful to marine biota. Bioassays provide information on the relative bioavailability and toxicity of sediment–sorbed contaminants under laboratory conditions where the effects of many natural environmental factors are controlled. The benthic community analyses provides corroborating evidence from resident biota regarding major compositional alterations to a component of the ecosystem under in situ conditions. The data from the three independent measures are complimentary and provide a preponderance of empirical evidence of both contamination and effects that can be used to classify the relative quality of sediments.

3. *Sediment Chemistry* - Sediment samples shall be measured for metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc), butyltin species, PCBs/PCTs, PAHs, TPH, and any other chemical constituent associated with shipbuilding and repair activities believed to be present in bay sediment. Additionally, sediment grain size distribution and TOC shall be measured to help interpret the concentrations of sediment contaminants and toxicity results.

4. *Sediment Toxicity* - Sediment toxicity shall be evaluated using whole sediment samples, sediment-water interface samples, and interstitial water samples. Toxicity of whole sediments will be measured using a 10-day amphipod (*Eohaustorius estuarius*) survival test, toxicity at the sediment water interface will be measured using the bivalve (*Mytilus edulis*) development test, and toxicity of interstitial water will be measured using the sea urchin (*S. purpuratus*) fertilization test. The amphipod survival test and sea urchin fertilization test provide acute and critical life stage effects data, respectively, while the bivalve development test will provide sublethal data on the effects of contaminant diffusion from whole sediment into the water.

5. *Benthic Community* - Benthic community structure analyses shall include identifying and enumerating the invertebrate organisms living in the sediments. The community shall be described using a variety of metrics, including conventional parameters such as total abundance and abundance of individual species, species diversity, and numbers of indicator taxa. In addition, the Bay Protection and Toxic Cleanup Program and/or the Southern California Bight 1998 Benthic Response Index for Bays and Harbors shall be used to identify stations containing degraded benthos. It is anticipated that the Bight 98 index will be available for use by the end of December 2001.

6. *Pore Water* – NASSCO and Southwest Marine shall specify a subset of sampling stations from the overall number of stations proposed for the Triad Approach to derive empirical sediment partition coefficients for the Equilibrium Partitioning Approach (discussed in Section VIII.B.2.). Pore water samples shall be measured for metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc), butyltin species, PCBs/PCTs, PAHs, TPH, and any other chemical constituent associated with shipbuilding and repair activities believed to be present in bay sediment. Additionally, the pore water samples shall be measured for ammonia to help interpret the concentrations of pore water contaminants and toxicity results. Sediment normalization shall also be conducted on the pore water samples to account for the bioavailability of the chemical of concern (e.g., TOC-normalization for nonionic organic chemicals and Acid Volatile Sulfide/Simultaneously Extracted Metals (AVS/SEM)-normalization for metals. Laboratory detection limits shall be established at or below California Toxics Rule (CTR) water quality criterion.

D. Aquatic-Dependent Wildlife and Human Health Investigation Spatial Site Assessment Guidelines

1. NASSCO and Southwest Marine shall review the sediment chemistry data collected from the site assessment and determine if contaminants listed in Appendix B, Table 1 are present in concentrations that have the potential to bioaccumulate in aquatic food webs. Appendix B, Table 1 is a listing of target analytes recommended by the EPA Fish Contaminant Workgroup ("*Guidance for Assessing Chemical Contaminant Data For Use in Fish Advisories*", Volume I – Fish Sampling and Analysis, Second Edition, September 1995, EPA 823-R-95-007). The target analytes consist of metals, organochlorine pesticides, organophosphate pesticides, chlorophenoxy herbicides, PAHs, PCBs, and dioxins/furans. NASSCO and Southwest Marine can exclude an analyte(s) from the recommended list if historic tissue or sediment data collected within their leaseholds indicate that an analyte(s) is not present at a level of concern to wildlife or human health, or if an

analyte(s) is not associated with shipbuilding and repair activities. Exclusion of any target analyte will require justification by NASSCO and Southwest Marine and approval from the Regional Board Executive Officer.

2. NASSCO and Southwest Marine shall identify and propose numerical fish/shellfish tissue residue guidelines (TRGs) for the protection of human health and aquatic-dependent wildlife. The TRGs shall be subject to the approval of the Regional Board Executive Officer. Current information indicates that the following guidelines can be used to evaluate the potential for the bioaccumulation of contaminants in aquatic food webs:

a) *TRGs for Human Health Protection* – The human health bioaccumulation tissue residue criteria established by the Office of Environmental Health Hazard Assessment (OHHEA).

b) *TRGs for Aquatic-Dependent Wildlife Protection* for aquatic-dependent wildlife protection - The wildlife bioaccumulation tissue residue criteria established by the New York State Department of Environmental Conservation, Division of Fish Wildlife, and Marine Resources.

3. NASSCO and Southwest Marine shipyards shall conduct 28-day sediment bioaccumulation tests using the burrowing clam, *Macoma nasuta* , for all contaminants identified as having potential to bioaccumulate in aquatic food webs to levels that would adversely affect aquatic-dependent wildlife or human health. *Macoma nasuta* is native to and widely distributed in San Diego Bay and actively ingest surface sediments. The shipyards shall specify the number and locations of sampling stations within and adjacent to their leaseholds to conduct the bioaccumulation tests.

4. NASSCO and Southwest Marine shall compare the tissue concentrations of the clams to: (1) Tissue residue guidelines described above, and (2) Tissue concentrations of clams exposed to reference sediments. The comparisons will be used to: (1) Evaluate the potential for contaminant uptake and subsequent food chain transfer of contaminants from the sediment, and (2) Determine the sediment areas where there is a potential for aquatic-dependent wildlife risks and human health risks associated with the contaminated sediment.

VIII SPATIAL DATA ANALYSIS

A. Conceptual Framework

1. NASSCO and Southwest Marine shall develop a conceptual framework for evaluating sediment quality within and adjacent to their leaseholds. The framework shall be consistent with the framework developed by EPA for the St. Louis River Area of Concern (*Development of a Framework for Evaluating Numerical Sediment Quality Targets and Sediment Contamination in the St. Louis River Area of Concern*, December 2000, EPA 905-R-00-008). The framework shall consist of: (1) Decision-making flow charts to evaluate each sample station for the following four indicators: sediment chemistry, toxicity (sediment, sediment-water interface, and pore water), benthic community structure, and bioaccumulation, and (2) A decision matrix based on the four indicators to assess the potential for impairment of aquatic life, aquatic-dependent wildlife, and human health beneficial uses.

2. Spatial Site Assessment Maps

a) *Modeling Program:* NASSCO and Southwest Marine shipyards shall illustrate the following using an appropriate modeling program:

(1) Horizontal and vertical distribution and magnitude of chemical contaminant concentrations for sediment areas containing contaminants exceeding background concentrations.

(2) Spatial distribution and magnitude of areas where there is a potential for aquatic life impairment (identified from the decision matrix).

(3) Spatial distribution and magnitude of areas where there is a potential for aquatic-dependent wildlife impairment (identified from the decision matrix).

(4) Spatial distribution and magnitude of areas where there is a potential for human health impairment (identified from the decision matrix).

b) *Thiessen Polygons:* The maps discussed above shall also be illustrated using Thiessen polygons or other equivalent methodology. Thiessen polygons are created by constructing straight lines from each station to every nearby selected station that can be reached without crossing any other straight line and then constructing the perpendicular bisector of each radius. Each Thiessen polygon will

represent the single station located within the polygon, and all points within a given Thiessen polygon are closer to that station than to any adjacent station. In complex, localized environments such as the shipyard sites, this method may be more accurate than contouring because of confounding interactions with boundary conditions (e.g., shoreline) and the patchy nature of elevated chemical concentrations.

IX NUMERCIAL DATA ANALYSIS TO DETERMINE SEDIMENT CLEANUP LEVELS

NASSCO and Southwest Marine shipyards shall develop sediment cleanup levels to protect aquatic life, aquatic-dependent wildlife and human health beneficial uses. The sediment cleanup levels that protect the aquatic life beneficial uses shall be developed based on the matched chemistry, toxicity and benthic community data generated during the spatial site assessment. The sediment cleanup levels that protect the aquatic-dependent wildlife and human health beneficial uses shall be developed based on a tiered bioaccumulation approach.

A. General Guidelines on Deriving Cleanup Levels

1. *Multiple Lines Of Evidence:* There are a variety of methods for assessing and classifying contaminated sediment for cleanup; each has its advantages and disadvantages. No single method can be used to derive cleanup levels because no single method measures all contaminated sediment impacts at all times and to all biological organisms. Accordingly the Regional Board is requiring the use of a “weight of evidence” approach incorporating multiple lines of evidence and the use of complimentary sediment classification methods to support the cleanup level decision making process. This approach will provide the Regional Board with a preponderance of evidence, developed through scientifically defensible methods, to establish sediment cleanup levels protecting the most sensitive beneficial use of San Diego Bay.

2. *Selection of Indicator Sediment Contaminants:* Based on the spatial data analysis results, NASSCO and Southwest Marine shipyards shall select a subset of chemicals for the development of site specific cleanup levels. These chemicals, termed “indicator pollutants” shall include and be representative of each of the major classes of sediment pollutants and sources (discharge pathways) occurring at the sites. NASSCO and Southwest Marine shipyards shall develop and document the rationale used in selecting the indicator pollutants.

B. Aquatic Life Cleanup Level Guidelines

NASSCO and Southwest Marine shipyards shall develop alternative

cleanup levels for each indicator pollutant using the Apparent Effects Threshold (AET) Approach and the Equilibrium Partitioning (EqP) Approach (See Appendix A, Figure 2). Other methodologies may be later specified by the Regional Board Executive Officer such as the Multivariate Data Analysis Approach to determine cleanup levels. Each cleanup level shall incorporate and describe an adequate margin of safety.

The use of the above methodologies provides multiple lines of evidence and allows for the integration of empirical data (from the AET approach) and theoretical/empirical information (from the EqP approach). The combination of these methodologies balances the uncertainties and limitations of any one method by incorporating the strengths of the other methods. Strong agreement in the results of each method will provide an independent validation of each method and a sound scientific basis to support the decision making process and final selected cleanup levels. Disagreement in the results of the methods will increase scientific uncertainty and indicate a need for caution in interpreting the data during the cleanup level decision making process.

1. *AET Approach:* By empirically determining the association between chemical contamination and adverse biological effects, predictions can be made regarding the levels of contamination that are always associated with adverse effects. The AET value for any given chemical is the concentration of that chemical, above which, statistically significant biological effects are always observed in the data set used to generate the AET. For any given chemical, sediment concentrations can be as high as the AET value and not be associated with statistically significant biological effects. If a chemical exceeds its AET for a particular biological indicator, then an adverse effect is predicted for that biological indicator.

a) *Number of Stations*: AETs can be expected to be most predictive of adverse biological effects associated with specific chemical concentrations when developed from a large database with wide ranges of chemical concentrations and a wide diversity of measured contaminants. Accordingly, NASSCO and Southwest Marine shipyards shall sample the triad of data (matched chemistry, toxicity, and benthic community structure) needed to develop the AET values from a sufficient number of stations. Available literature suggests that a minimum of 30-50 stations are required to develop AET cleanup levels. The shipyards shall propose the number of stations that will be used to develop AET cleanup levels for NASSCO and Southwest Marine and incorporate those stations into the spatial site assessment. The justification of the proposed number of stations shall be submitted and will be subject to the approval of the Regional Board Executive Officer.

b) *Range of Biological Effects:* NASSCO and Southwest Marine shipyards shall develop proposed cleanup levels using the AET approach for each indicator pollutant. The protectiveness of an AET can be ensured by evaluating organisms and biological responses with different degrees of sensitivity to chemical toxicity. Accordingly, the determination of the AET value for each indicator pollutant shall be based on the following suite of acute and sublethal biological effects (i.e. biological endpoints or indicators):

(1) Toxicity of bulk sediments will be measured using a 10-day amphipod (*E. estuarius*) survival test.

(2) Toxicity of interstitial water will be measured using the sea urchin (*S. purpuratus*) fertilization test.

(3) Toxicity of the sediment-water interface will be measured using the mussel (Mytilus edulis) development test.

(4) Benthic community degradation.

c) *Lowest Apparent Effects Threshold (LAET):* In order to provide confidence that the most sensitive aquatic organisms are reasonably protected the AET cleanup level(s) shall be defined by the LAET value for each indicator pollutant. By definition, the LAET cleanup level is expected to be protective of a wide range of adverse biological effects. Available literature indicates LAET values can be 90 to 94 percent sensitive in correctly predicting all known biological effects in the database used to generate the AET values.

2. *EqP Approach*: The EqP approach can be either an empirical or theoretical method that correlates interstitial water (pore water) concentrations of contaminants with bulk sediment chemical concentrations. Chemical concentrations in pore water can be most directly related to chemical concentrations in sediment either through: (1) Direct measurement of pore water and sediment concentrations (empirical), or (2) Chemical partitioning coefficients based on information from the scientific literature and measured sediment concentrations (theoretical).

In the EqP approach, water quality criteria developed for the protection of marine organisms are used as the basis for developing sediment quality criteria. As such, the water quality criteria formulated for the protection of water column species are assumed to be applicable to benthic organisms. The calculation procedure for establishing sediment quality criteria using the EqP approach consists of multiplying the partition coefficient, Kp, with

the water quality criteria for the chemical of interest. Hence, the sediment quality value is the sediment concentration that would correspond to a pore water concentration equivalent to the CTR water quality criterion.

a) NASSCO and Southwest Marine shall use the synoptic pore water chemistry and sediment chemistry data generated from the spatial site assessment to develop a wide range of empirically derived partition coefficients, Kp.

b) The proposed sediment cleanup levels shall be established at chemical concentrations that ensure pore water concentrations do not exceed water quality criteria as established in the CTR.

3. Validation of Aquatic Life Cleanup Levels

a) *Sensitivity and Reliability:* NASSCO and Southwest Marine shipyards shall assess the predictions made by the AET and EqP approaches (i.e., cleanup levels) by measuring their respective overall reliabilities. The overall reliability of any sediment quality approach addresses the following components:

(1) Sensitivity: Represents the ability of sediment quality values to correctly identify all stations in a data set that actually have biological impacts.

(2) Efficiency: Represents the ability of sediment quality values to identify only stations that actually have biological impacts.

The overall reliability measure is defined as the proportion of all stations for which correct predictions were made for either the presence or absence of adverse biological effects:

<u>Overall Reliability</u> = [All stations correctly predicted as impacted + All stations correctly predicted as nonimpacted] / [Total number of stations evaluated]

b) *Sediment Serial Dilution Toxicity Tests*. The Sediment Serial Dilution Toxicity Test (SSDTT) approach involves exposing test organisms to whole sediment or pore water that have exhibited toxicity in previous testing and serial diluting the sample by 50 percent to establish a cause and effect relationship between chemicals in the sediment or pore water and adverse biological responses. This approach can be used to confirm the biological effects of contaminants in sediment and pore water. This approach

can also be used to provide experimental validation of cleanup levels generated by the AET and EqP approaches. The concentration of sample sediment to clean reference station sediment will be 0 (control) 12.5, 25, 50, and 100 percent.

(1) The biological test organisms used should be the amphipod (*E. estuarius*) and the sea urchin (*S. purpuratus*).

(2) Biological and chemical data from the serial diluted sediments shall be statistically compared with reference station data to determine the occurrence of biological effects. The Median Lethal Concentration (LC_{50}) values, Median Effective Concentration (EC_{50}) values, lowest observable effect concentrations and no-effect concentrations shall be determined for each indicator pollutant.

(3) Data correlating observed biological effects with chemical concentrations in the serial diluted sediment should be used to calculate probit curves for deriving biological effect sediment contaminant values.

(4) The results of the SSDTT approach shall be compared with the results of cleanup levels generated by the AET and EqP approaches. A determination shall be made on whether the results of the SSDTT approach validate the cleanup levels derived through the AET and EqP approaches.

C. Aquatic-Dependent Wildlife Cleanup Level Guidelines

NASSCO and Southwest Marine shipyards shall develop cleanup levels for each contaminant associated with contaminant concentrations harmful to aquatic-dependent wildlife in the food web. NASSCO and Southwest Marine shall use a tiered methodology based on the Tissue Residue Approach (TRA) to assess the potential for impairment to the aquatic-dependent wildlife beneficial uses (See Appendix A, Figure 3). Each cleanup level shall incorporate and describe an adequate margin of safety.

1. *Tissue Residue Approach:* The TR approach (which is also known as the biota-water-sediment equilibrium partitioning approach) is premised on the fact that sediments represent important sources of bioaccumulative contaminants in aquatic food webs. For this reason, it is necessary that the sediment contaminant concentrations remain below the levels that bioaccumulate to harmful levels in the food web. Therefore, the TR approach establishes safe sediment concentrations for individual chemicals or classes of chemicals by determining the chemical

concentrations in sediments that are predicted to result in acceptable tissue residues.

Derivation of numerical cleanup levels using the TR approach involves several steps. As a first step, the contaminants for which cleanup levels are to be derived are selected based on their potential to accumulate in aquatic food webs. Next, numerical TRGs are identified for these contaminants. While most of the available TRGs are intended to provide protection for human health, it is also important to obtain TRGs that are explicitly designed to protect piscivorus wildlife species. Following the selection of TRGs, biota-to-sediment accumulation factors (BSAFs) are determined for each of the substances of concern. Such BSAFs can be determined from the results of bioaccumulation assessments, from matching sediment chemistry and tissue residue data, or from the results of bioaccumulation models.

Numerical cleanup levels are subsequently derived using the equation: *Numerical cleanup level = TRG ÷ BSAF*

a) If there is a potential for aquatic-dependent wildlife impairment based on the 28-day sediment bioaccumulation tests, as discussed in Section VI.D.4. then NASSCO and Southwest Marine Shipyards shall directly measure tissue concentrations in resident biota (fish and/or shellfish) and compare the contaminant concentrations in the tissue to the tissue residue guidelines.

b) NASSCO and Southwest Marine shipyards shall propose target species for measuring tissue contaminant concentrations and determining the rate of contaminant uptake. If practicable and appropriate, the target species provided in Appendix C, Table 1 shall be used. Appendix C, Table 1 is a list of target species for use in southern California estuaries and marine waters recommended by the EPA Fish Contaminant Workgroup (“Guidance for Assessing Chemical Contaminant Data For Use in Fish Advisories”, Volume I – Fish Sampling and Analysis, Second Edition, September 1995, EPA 823-R-95-007).

c) NASSCO and Southwest Marine shipyards shall identify and propose numerical TRGs for the protection of aquatic-dependent wildlife. The TRGs shall be subject to the approval of the Regional Board Executive Officer. Current information indicates that the wildlife bioaccumulation tissue residue criteria established by the New York State Department of Environmental Conservation, Division of Fish Wildlife, and Marine Resources can be used to evaluate the potential for the bioaccumulation of contaminants in aquatic

food webs.

d) NASSCO and Southwest Marine shipyards shall develop cleanup levels using BSAFs if the contaminant concentrations in the sampled tissue exceed the tissue residue guidelines. The cleanup levels shall assure that the concentrations of contaminants in the sediment remain below the levels that are associated with the bioaccumulation of such contaminants to harmful levels in the food web.

D. Human Health Risk Cleanup Level Guidelines

NASSCO and Southwest Marine shipyards shall develop cleanup levels for each contaminant associated with contaminant concentrations harmful to human health in the food web. NASSCO and Southwest Marine shall use a tiered methodology based on the TR Approach (described above) to assess the potential for impairment to human health beneficial uses (See Appendix A, Figure 4). Each cleanup level shall incorporate and describe an adequate margin of safety.

1. If there is a potential for human health impairment based on the 28-day sediment bioaccumulation tests, as discussed in Section VI.D.4. (4), then the Shipyards shall directly measure tissue concentrations in the resident biota (fish and shellfish) and compare the contaminant concentrations in the tissue to the tissue residue guidelines.

2. NASSCO and Southwest Marine shipyards shall propose target species for measuring tissue contaminant concentrations and determining the rate of contaminant uptake. The target species shall be subject to the approval of the Regional Board Executive Officer. If practicable and appropriate, the target species provided in Appendix C shall be used. Appendix C is a list of target species for use in southern California estuaries and marine waters recommended by the EPA Fish Contaminant Workgroup ("Guidance for Assessing Chemical Contaminant Data For Use in Fish Advisories", Volume I – Fish Sampling and Analysis, Second Edition, September 1995, EPA 823-R-95-007).

3. The shipyards shall identify and propose numerical tissue residue guidelines for the protection human health. The tissue residue guidelines shall be subject to the approval of the Regional Board Executive Officer. Current information indicates that the human health bioaccumulation tissue residue criteria established by the OEHHA can be used to evaluate the potential for the bioaccumulation of contaminants in aquatic food webs.

4. NASSCO and Southwest Marine shipyards shall develop cleanup levels using BSAFs if the contaminant concentrations in the sampled tissue exceed the tissue residue guidelines. The cleanup levels shall assure that the concentrations of contaminants in the sediment remain below the levels that are associated with the bioaccumulation of such contaminants to harmful levels in the aquatic food web.

E. Sediment Cleanup Level Maps

1. *Modeling Program:* NASSCO and Southwest Marine shipyards shall illustrate the following using an appropriate modeling program:

a) Sediment areas containing contaminants exceeding LAET cleanup levels;

b) Sediment areas containing contaminants exceeding EqP cleanup levels;

c) Sediment areas containing contaminants exceeding other criteria that may be later specified by the Regional Board Executive Officer such as the multivariate data analysis;

d) Sediment areas containing contaminants exceeding the Aquatic-Dependent Wildlife cleanup levels; and

e) Sediment areas containing contaminants exceeding the Human Health cleanup levels.

2. *Thiessen Polygons:* The maps discussed above shall also be illustrated using Thiessen polygons or other equivalent methodology. Thiessen polygons are created by constructing straight lines from each station to every nearby selected station that can be reached without crossing any other straight line and then constructing the perpendicular bisector of each radius. Each Thiessen polygon will represent the single station located within the polygon, and all points within a given Thiessen polygon are closer to that station than to any adjacent station. In complex, localized environments such as the shipyard sites, this method may be more accurate than contouring because of confounding interactions with boundary conditions (e.g., shoreline) and the patchy nature of elevated chemical concentrations.

X CLEANUP ALTERNATIVES ANALYSES

NASSCO and Southwest Marine shipyards shall evaluate the technological and economic feasibility of a cleanup strategy to attain each of the sediment cleanup levels established under the preceding Section I VIII including: (1) Sediment

cleanup levels to attain background conditions or levels as close to background as possible; (2) Sediment cleanup levels to protect aquatic life beneficial uses; (3) Sediment cleanup levels to protect aquatic-dependent wildlife beneficial uses and (4) Sediment cleanup levels to protect human health beneficial uses.

A. Technical feasibility shall be determined by assessing the technologies which are effective in reducing the contaminant concentrations to the established cleanup levels. The USEPA Report Selecting Remediation Techniques for Contaminated Sediment (EPA-823-B-93-001) provides a more detailed explanation of these cleanup alternatives. NASSCO and Southwest Marine shipyards shall document their selection rationale and justification as to the applicability or inapplicability or practicality of the various technologies. The following cleanup and abatement methods, or combinations thereof, shall be reviewed and considered for each alternative cleanup level to the extent that the methods are applicable to the contaminated sediment site(s).

- Dredging w/disposal or reuse of dredged material
- Subaqueous Capping
- Treatment
- No Action

The criteria to be considered for each alternative cleanup and abatement method are described below.

1. Dredging

a) There is no single dredge technology that is the universal solution for cleanup of contaminated sediment. Typical dredging methods include mechanical or hydraulic dredging. The following factors should be considered in the selection of the dredging process:

- Physical characteristics of the contaminated sediment to be dredged.
- Quantity of contaminated sediment to be dredged.
- Depth of water overlying the contaminated sediment.
- Temporary storage or staging of the material, the ultimate. disposal site for the material once it is removed, and the distance to an authorized contaminated sediment disposal area.
- Concentration of contaminants in the sediment to be dredged.
- Mobility of contaminants in the sediment and containment capability of the methods employed.
- Method of disposal for the dredged material.
- Types of dredging equipment available.
- Currents and waves.

- Access to the site.

b) The dredging process can disturb bottom sediments leading to the release of contaminants into the water column by resuspension of contaminated sediment particles, dispersal of interstitial water in the sediment pores and desorption of contaminants from the contaminated sediment. It is critical that the dredging process be designed to limit sediment resuspension. This will reduce the potential for release of contaminants to the water column during the dredging process and reduce the possibility that the contaminants will spread to previously uncontaminated sediment areas. Technologies to reduce resuspension and potential recontamination shall be utilized. Examples of such technologies include silt curtains constructed of geotextile fabrics.

c) Potential alternatives for the disposal of dredged material from San Diego Bay include:

- Incineration;
- Upland disposal without treatment;
- Upland disposal with treatment; or
- Confined aquatic disposal.

d) Reuse of remediated material may include:

- Beach replenishment;
- Habitat restoration/ enhancement;
- Ocean disposal; or
- Reuse sites such as capping.

Most of these items are further discussed in the section titled Disposal of Dredged Material in the San Diego Region Basin Plan, Chapter Four.

e) Removal often involves consolidation using a diked structure which retains the dredged material. Considerations include:

- Construction of the dike or containment structure to assure that contaminants do not migrate,
- The period of time for consolidation of the sediments,
- Staging or holding structures or settling ponds,
- De-watering issues, including treatment and discharge of wastewater,
- Transportation of dredged material, i.e., pipeline, barge, rail, truck,

- Regulatory constraints.

2. Subaqueous Capping

a) Subaqueous capping refers to the placement of a clean material over the contaminated sediment. Capping may be the preferred alternative where the costs and environmental effects of moving or treating the contaminated sediments are too great. The cover material must minimize the migration of contaminants from the sediment to the water column. Subaqueous capping requires long-term monitoring to measure changes in cap thickness, erosion around cap boundaries, and possible leakage of contaminants through the cap.

b) The following criteria must be satisfied to allow implementation of a subaqueous cap:

(1) All point and non-point source discharges to the cap area must be identified and terminated.

(2) The cap must provide adequate coverage of contaminated sediments. The capping materials must be suitable for easy and accurate placement.

(3) The cap design must inhibit burrowing organisms from penetrating the cap and re-exposing contaminated sediments (bioturbation).

(4) The contaminated sediments must have the ability to support the cap (i.e. the cap will not cause settlement or loading).

(5) During seismic events, the bottom topography must not allow sloping or slumping of the capped sediments. The seismic design of the cap should be conducted as required by California Code of Regulations Title 23, Division 3, Chapter 15 (Chapter 15). Section 2547 of Chapter 15 requires Class I and II waste management units to be designed to withstand the Maximum Credible Earthquake and Class III waste management units to be designed to withstand the Maximum Probable Earthquake.

(6) Hydrologic conditions must not disturb the site, and natural or human activities must not compromise the integrity of the cap. The cap area must be protected against erosion or disruption by currents, waves, propeller wash, or ship hulls.

(7) The potential of shipping channels, channel maintenance dredging, or other present and future harbor

development projects to disrupt the integrity of the cap must be considered.

(8) The capped area must be noted on appropriate maps, charts, and deeds to document the exact location of the site. Section 2511 (d) of the California Code of Regulations Title 23, Division 3, Chapter 15 regulations (Chapter 15) provides that remedial actions intended to contain waste at the point of release, such as a subaqueous cap, must conform to applicable provisions of the Chapter 15 regulations to the extent feasible. Recognition is made that many of the Chapter 15 regulations pertaining to liners, subsurface barriers, geologic criteria, ground water monitoring, precipitation and drainage controls etc. are obviously not applicable to a subaqueous cap. However, there are some Chapter 15 regulations which are applicable.

3. Treatment

a) Site treatment involves the physical or contaminant alteration of the sediment. The treatment must reduce or eliminate the toxicity, mobility, or volume of contaminated material such that compliance with State Board Resolution 92-49 is achieved. Treatment may be either in-situ or ex-situ. In-situ and ex-situ treatment requires uniform treatment and documentation of effectiveness. Ex-situ treatment generally requires a dedicated treatment area.

b) Types of treatment may include:

- biological,
- dechlorination,
- soil washing,
- solvent extraction,
- solidification,
- incineration,
- thermal desorption, and
- contaminant fixation

c) Appropriate treatment methods depend upon the contaminant characteristics, as well as physical characteristics of the sediments (e.g. clay content, organic carbon content, salinity, and water content). Some treatment options produce by-products which require further handling. Although the above technologies are currently being employed for soils, their effectiveness for use in marine sediments should be thoroughly evaluated. Bench tests and pilot projects should be performed to document the efficacy of the treatment method if the effectiveness of the

treatment method is not well documented.

4. No action

a) The "no action" alternative involves reliance upon natural processes for managing contaminated sediment. Examples of the natural processes include:

- Burial of the contaminated sediment by natural sedimentation
- Dispersal of contaminants by natural processes
- Natural detoxification of contaminated sediments

b) The no action alternative may include posting of warning signs, restricting access to the site, and monitoring of water, sediments, or organisms.

c) If a no-action alternative is recommended, the following information must be submitted: 1) compelling evidence must be provided that no remediation technologies should be applied and only the no-action alternative is feasible at the site, and 2) a cleanup cost comparison of all other remediation technologies versus the no-action alternative, and a detailed proposed monitoring program. The monitoring program should be designed to measure changes in discharge rates from the site and to show whether rates of contaminant release and the area of influence of the contaminants are accelerating. The duration of the monitoring and all organizations which will implement the monitoring shall be identified.

d) The Regional Board will require NASSCO and Southwest Marine shipyards to demonstrate some or all of the following items before consideration of the no-action alternative:

(1) All contaminant discharges from all sources have been halted;

(2) The costs and environmental effects of moving and treating contaminated sediment are outweigh the costs and environmental effects of leaving the material in-place;

(3) Hydrologic conditions will not disturb the site;

(4) The contaminated sediment will not be re-mobilized by human or natural activities, such as by shipping activity or bioturbation;

(5) The contaminated sediments at the site will not spread;

(6) Burial or dilution processes are rapid;

(7) Uncontaminated sediments will integrate with contaminated sediments through a combination of dispersion, mixing, burial, and/or biological degradation;

(8) Notices to abandon the site including a list of all contaminants known or suspected, concentrations of contaminants, estimate of the total amount of contaminants, potential hazards to human health, toxicity and bioaccumulation potential in sport or commercial fish and shellfish will be issued to appropriate federal, state, and local agencies and to the public including the US Army Corps of Engineers, US Coast Guard, local harbor authorities, county health officer, California Coastal Commission, State Lands Commission, State and federal fish and wildlife agencies, local environmental groups, and local water user groups; and

(9) The exact location and depth of the site, with a list of contaminants and their quantities, will be noted on appropriate deeds, maps, and navigational charts such as those prepared by the US Army Corps of Engineers, US Coast Guard, National Oceanographic and Atmospheric Administration, Coastal Commission, State Lands Commission, and harbor authorities.

B. Economic feasibility refers to the objective balancing of the incremental benefit of attaining more stringent cleanup levels compared with the incremental cost of achieving those levels. Economic feasibility does not refer to the subjective measurement of the shipyards' ability to pay the costs.

1. NASSCO and Southwest Marine shipyards shall provide a cost and feasibility analysis for each applicable cleanup and abatement methodology described above to achieve each of the various cleanup levels.

2. NASSCO and Southwest Marine shipyards shall obtain at least two direct cost quotes from reliable companies for each applicable cleanup alternative. Obtaining direct quotes assures that all aspects of the project are included in the final estimate. These will also help refine the remedial design and the selection of the technology, for instance, selecting the appropriate type of dredging method, designing the appropriate type of containment structure, determining the method for transport of dredged sediments, or selecting the type of pretreatment or effluent treatment methods. Include the following, where applicable for each:

- Assumptions,
- Capital costs,

- Operation and Maintenance Costs,
- Unit costs with subtotals, and
- Sources of cost estimates.

3. In evaluating the economic feasibility of the strategies, NASSCO and Southwest Marine shipyards shall consider the factors described in Water Code Section 13000 and Resolution 92-49, Directive III.G. including all demands being made and to be made on San Diego Bay waters and the total values involved, beneficial and detrimental, economic and social, tangible and intangible. The factors to be considered shall also include the following beneficial effects and potential adverse effects of remediating contaminated sediments:

Beneficial Effects of Sediment Cleanup	Values Quantifying These Beneficial Uses	Beneficial Use Affected
Lower toxicity in planktonic and benthic organisms	Greater survival of organisms in toxicity tests.	MAR, EST
Undegraded benthic community	Species diversity and abundance characteristic of undegraded conditions.	MAR, EST
Lower concentrations of pollutants in water	Water column chemical concentration that will not contribute to possible human health impacts.	MIGR, SPWN, EST, MAR, REC 1, REC 2
Lower concentrations of pollutants in fish and shellfish tissue	Lower tissue concentrations of chemicals that could contribute to possible human health and ecological impacts.	MAR, EST, REC 1, COMM
Area can be used for sport and commercial fishing	Anglers catch more fish. Impact on catches and net revenues of fishing operations increase.	REC 1, COMM
Area can be used for shellfish harvesting or aquaculture	Jobs and production generated by these activities increase. Net revenues from these activities are enhanced.	SHELL, AQUA
Improved conditions for seabirds and other predators	Increase in populations. Value to public of more abundant wildlife.	WILD, MIGR, RARE
More abundant fish populations	Increase in populations. Value to public of more abundant wildlife.	MAR, EST
Commercial catches increase	Impact on catches and net revenues of fishing operations	COMM
Recreational catches increase, more opportunities for angling	Increased catches and recreational visitor-days.	REC 1

Beneficial Effects of Sediment Cleanup	Values Quantifying These Beneficial Uses	Beneficial Use Affected
Improved ecosystem conditions	Species diversity and abundance characteristic of undegraded conditions.	EST, MAR
Improved aesthetics	Value to public of improved aesthetics. In some cases, estimates of the value to the public of improved conditions may be available from surveys.	REC 2
More abundant wildlife, more opportunities for wildlife viewing	Impact on wildlife populations. Impact on recreational visitor-days.	MAR, WILD, RARE, REC 2

Potential Adverse Effects of Sediment Cleanup	Environmental Factor Affected
Emissions from dredging, excavation, transport, disposal and capping equipment	Air Quality
Odor from dredged material if reused	Air Quality
Short-term impacts on aquatic resources from high chemical concentrations of turbidity	Surface Water Column and Sediments
Runoff from excavated or disposed material	Surface Water Column and Sediments
Leaching of pollutants from capped area into surface water & sediment	Surface Water Column and Sediments
Alterations of currents or course of water movement	Geology and groundwater
Destabilization of channel slopes and undermining pilings	Geology and groundwater
Destabilization of sediments under cap	Sediments, geology and groundwater
Turbidity disrupting sensitive spawning or migrating fish species	Biological resources
Sensitive species displacement by removal of habitat or burial or contamination of sensitive habitats due to excessive turbidity	Biological resources
Access to berths by ships or recreational boating could be altered	Transportation

XI **SELECTION OF TARGET CLEANUP LEVEL**

Under the terms of Resolution No. 92-49, the Regional Board is obligated to have a presumptive goal of cleanup to attain background water quality conditions. If, based on the technological and economic feasibility analyses for the cleanup levels and methodologies previously discussed, the shipyards determine that cleanup to background is not feasible, they shall propose cleanup levels that are as close to background conditions as possible and do not unreasonably affect present and anticipated beneficial uses of San Diego Bay.

The Regional Board may accept a cleanup level above background water quality conditions, only if the Board reviews the shipyards' justifications for proposing an

alternative cleanup level and determines that it is technologically or economically infeasible to achieve background water quality conditions. If the Regional Board makes such a determination, the Board will then select a cleanup level that is based on the lowest levels which are technologically or economically achievable and that will not unreasonably affect present and anticipated beneficial uses of waters of the Region.

APPENDIX A

PROCESS ACTIVITES TO DETERMINE SEDIMENT CLEANUP LEVELS

FIGURE 1 - NASSCO & Southwest Marine Shipyards Cleanup Level & Methodolgy Selection

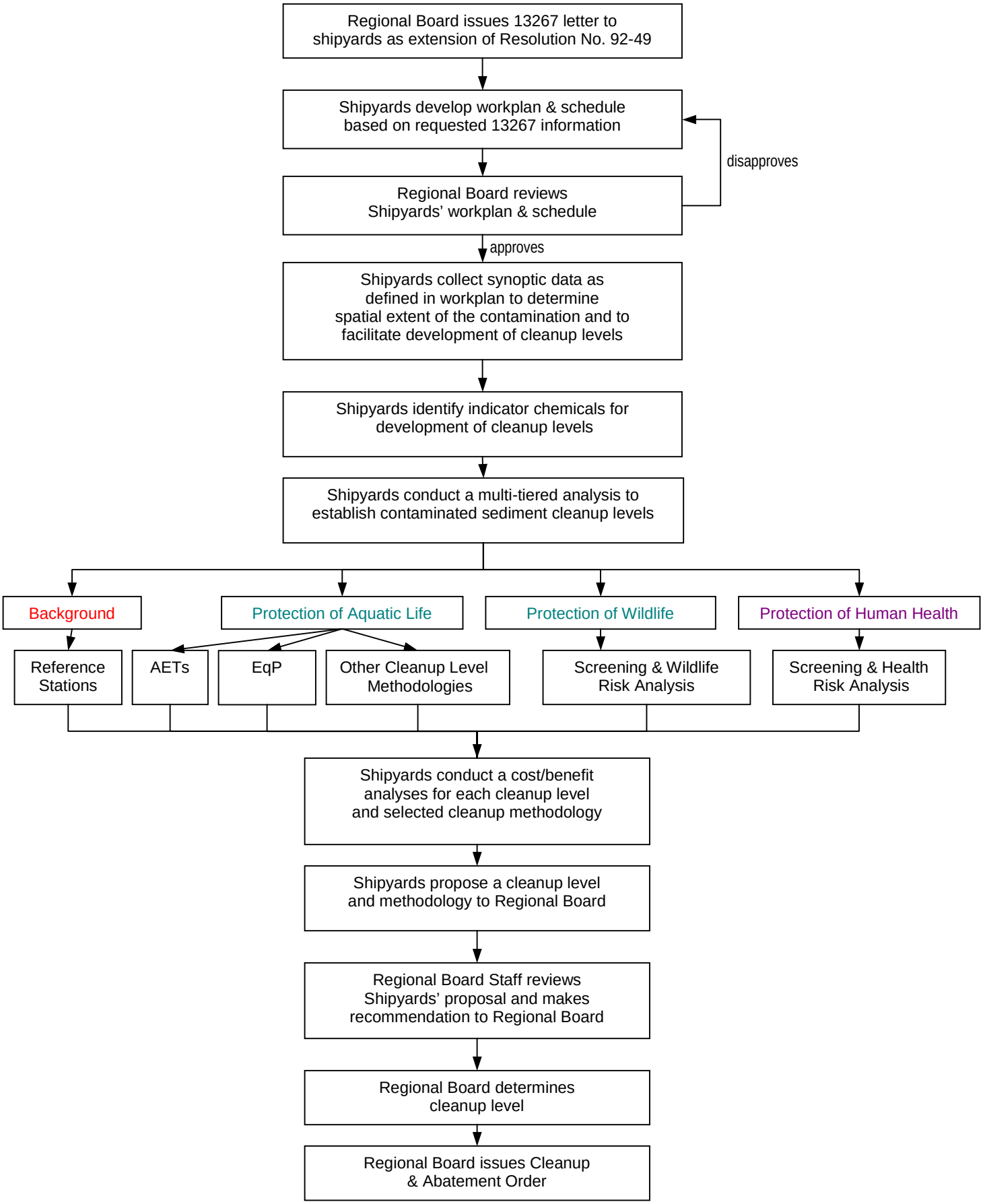


FIGURE 2 - Sediment Cleanup Levels to Protect Aquatic Life

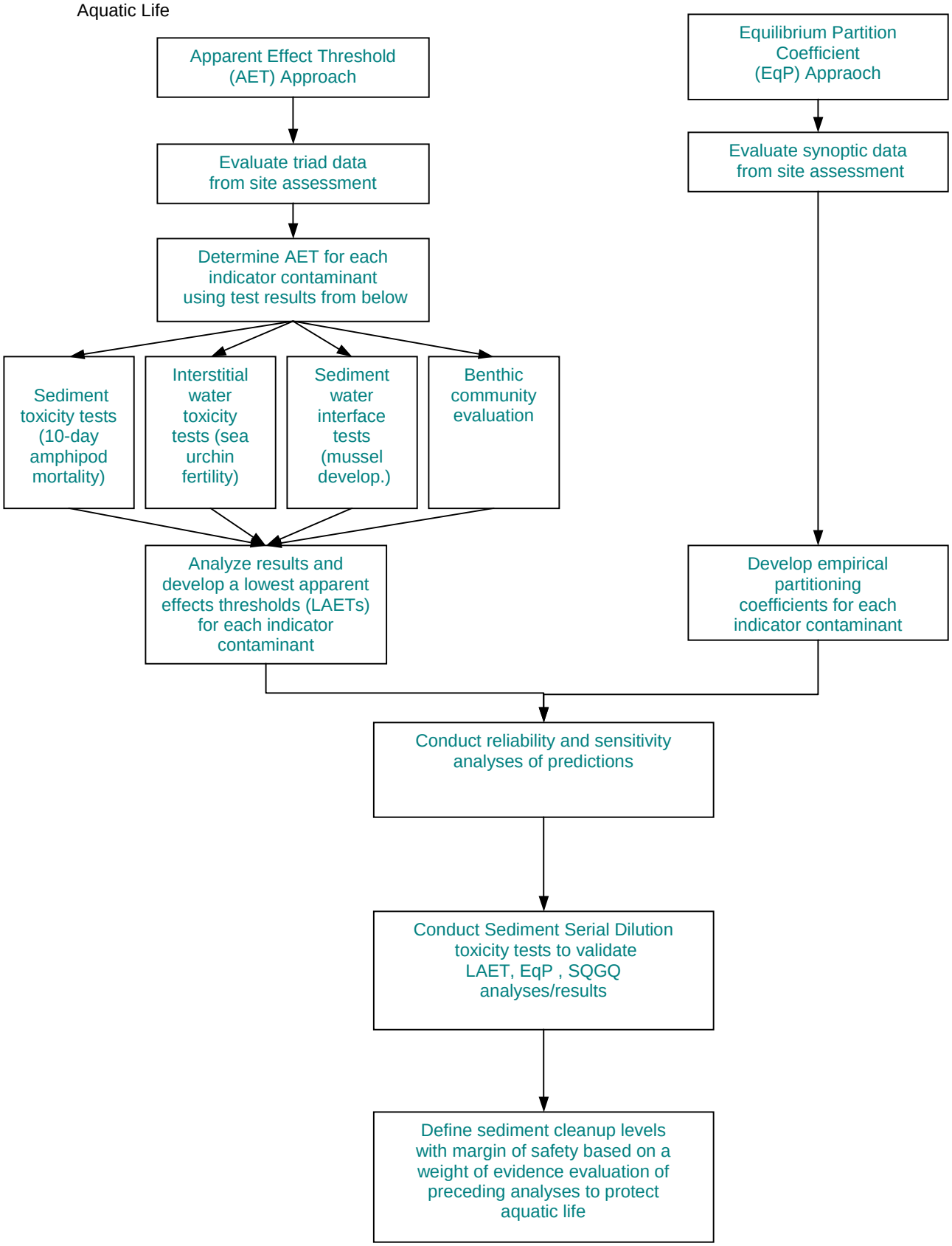


FIGURE 3 - Sediment Cleanup Levels to Protect Aquatic-Dependent Wildlife

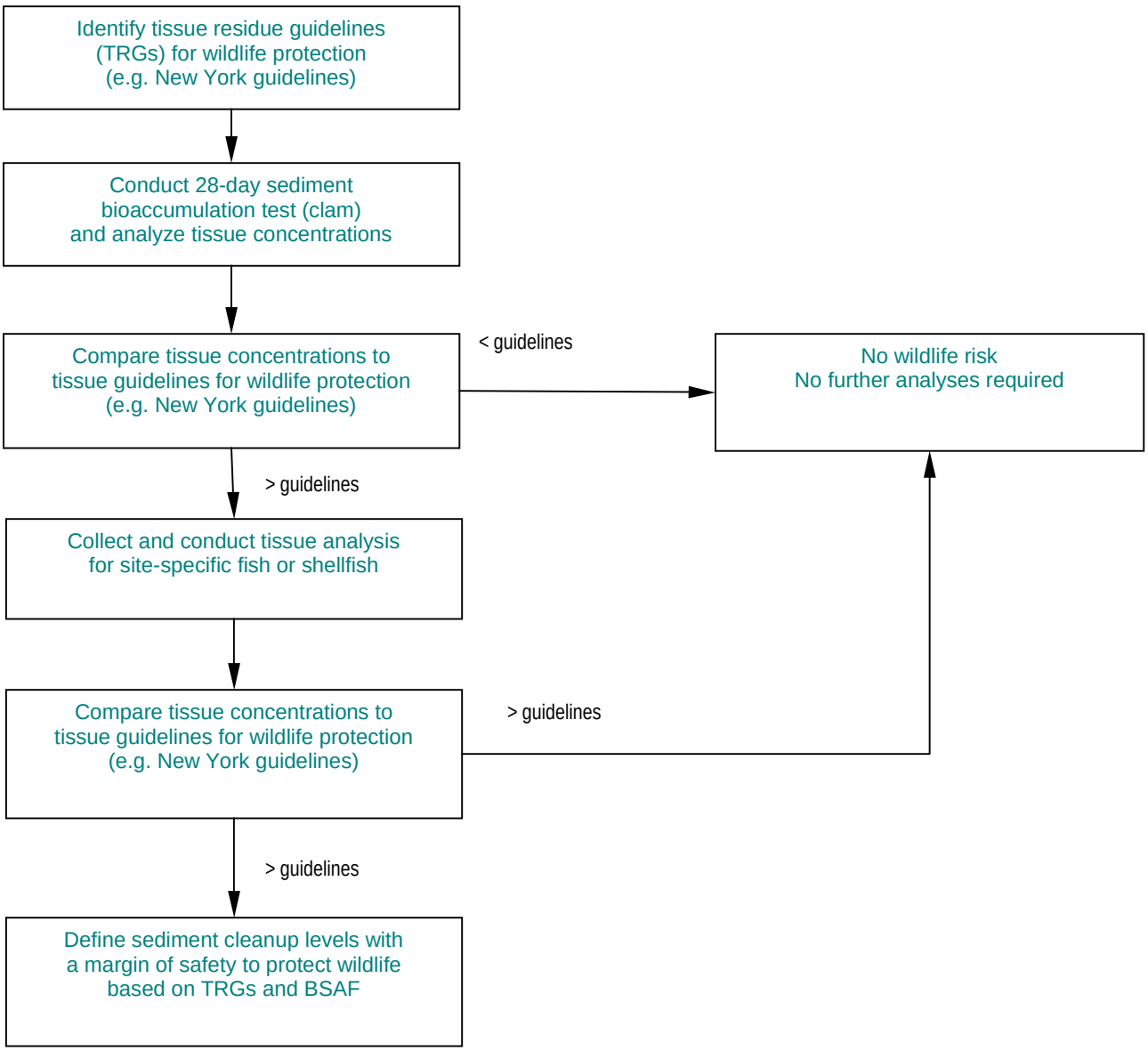
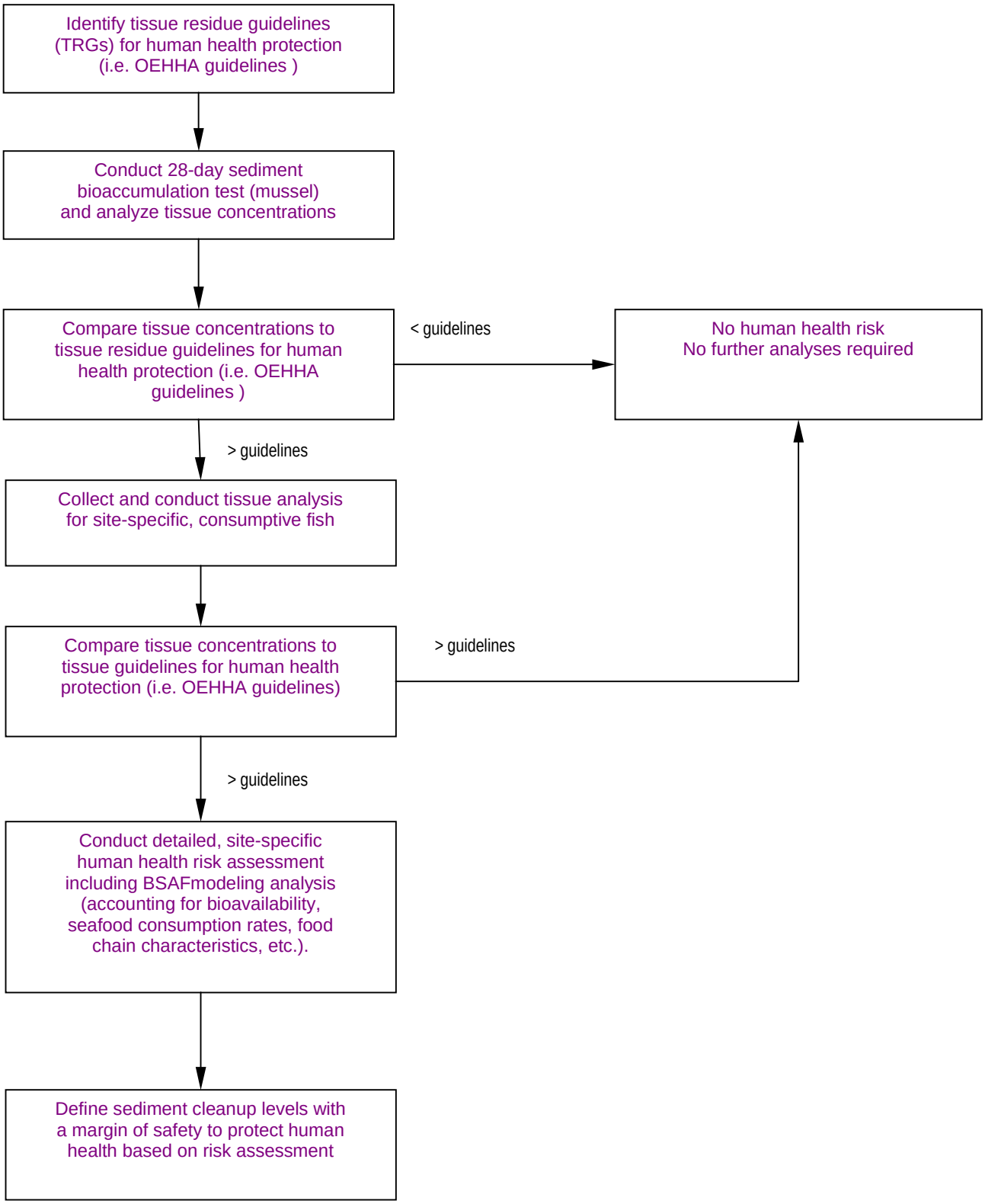


Figure 4 - Sediment Cleanup Levels to Protect Human Health



APPENDIX B

EPA RECOMMENDED TARGET ANALYTES FOR FISH AND SHELLFISH

Table 1. Recommended Target Analytes[a]

Metals	Organophosphate Pesticides[8]
Arsenic (inorganic)	Chlorpyrifos
Cadmium	Diazinon
Mercury	Disulfoton
Selenium	Ethion
Tributyltin	Terbufos
Organochlorine Pesticides	Chlorophenoxy Herbicides
Chlordane, total (cis- and trans-chlordane, cis- and trans-nonachlor, oxychlordane)	Oxyfluorfen
DDT, total (2,4'-DDD, 4,4'-DDD, 2,4'-DDE, 4,4'-DDE, 2,4'-DDT, 4,4'-DDT	PAHs[f]
Dicofol	PCBs
Dieldrin	Total Aroclors[g]
Endosulfan (I and II)	
Endrin	Dioxins / furans [h, I]
Heptachlor epoxide[b]	
Hexachlorobenzene	
Lindane (γ-hexachlorocyclohexane; γ-HCl)[c]	
Mirex[d]	
Toxaphene	

PAHs = Polycyclic aromatic hydrocarbons
PCBs = Polychlorinated biphenyls

[a] States should include all recommended target analytes in screening studies, if resources allow, unless historic tissue or sediment data indicate that an analyte is not present at a level of concern for human health. Additional target analytes should be included in screening studies if States have site-specific information (e.g. historic tissue or sediment data, discharge monitoring reports from municipal and industrial sources, pesticide use application information) that these chemicals may be present at levels of concern for human health.

[b] Heptachlor epoxide is not a pesticide but is a metabolite of the pesticide heptachlor.

[c] Also known as γ-benzene hexachloride (γ-BHC).

[d] Mirex should be regarded primarily as a regional target analyte in the southeast and Great Lakes States, unless historic tissue, sediment, or discharge data indicate the likelihood of its presence in other areas.

[e] The reader should note that carbophenothion was included on the original list of target analytes. Because the registrant did not support reregistration for this chemical, it will not longer be used. For this reason and because of its use profile, carbophenothion was removed from the recommended list of target analytes.

[f] It is recommended that, in both screening and intensive studies, tissue samples be analyzed for benzo[*a*]pyrene, benz[*a*]-anthracene, benzo[*b*]fluoranthene, benzo[*k*]fluoranthene, chrysene, dibenz[*a,h*]anthracene, and indeno [*1,2,3-co*]pyrene, and that the order-of-magnitude relative potencies given for PAHs in the EPA provisional guidance for quantitative risk assessment of PAHs (U.S. EPA, 1993c) be used to calculate a potency equivalency concentration (PEC) for each sample for comparison with the recommended SV for benzo[*a*]pyrene (see Section 5.3.2.3). At this time, EPA's recommendation for risk assessment of PAHs (U.S. EPA, 1993c) is considered provisional because quantitative risk assessment data are not available of all PAHs. This approach is under Agency review and over the next year will be evaluated as new health effects benchmark values are developed. Therefore, the method provided in this guidance document is subject to change pending results of the Agency's reevaluation.

[g] Analysis of total PCBs, as the sum of Arochlor equivalents, is recommended in both screening and intensive studies because of the lack of adequate toxicologic data to develop screening values (SVs) for individual PCB congeners (see Section 4.3.5). However, because of the wide range of toxicities among different PCB congeners and the effects of metabolism and degradation on Aroclor composition in the environment, congener analysis is deemed to be a more scientifically sound and accurate method for determining total PCB concentrations. Consequently, States that currently do congener-specific PCB analyses should continue to do so. Other States are encouraged to develop the capability to conduct PCB congener analysis.

[h] Note: The EPA Office of Research and Development is currently reassessing the human health effects of dioxins / furans.

[i] Dixons / furans should be considered for analysis primarily at sites of pulp and paper mills using a chlorine bleaching process and at industrial sites where the following organic compounds are formulated: herbicides (containing 2,4,5-trichlorophyoxy acids and 2,4,5-trichlorophenonl), hexachlorophene, pentachlorophenol, and PCBs (U.S. EPA 1987d). It is recommended that the 2,3,7,8-substituted tetra- through octa-chlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) be determined and a toxicity-weighted total concentration calculated for each sample (Barnes and Bellin, 1989; U.S. EPA, 1987d) (see Section 5.3.2.4). If resources are limited, 2,3,7,8-TCDD and 2,3,7,8-TCDF should be determined at a minimum.

APPENDIX C

TARGET SPECIES FOR USE IN SOUTHERN CALIFORNIA ESTUARIES AND MARINE WATERS RECOMMENDED BY THE EPA FISH CONTAMINANT WORKGROUP ("GUIDANCE FOR ASSESSING CHEMICAL CONTAMINANT DATA FOR USE IN FISH ADVISORIES", VOLUME I – FISH SAMPLING AND ANALYSIS, SECOND EDITION, SEPTEMBER 1995, EPA 823-R-95-007)

Table 1. Recommended Target Species for Southern California Estuaries and Marine Waters (Santa Monica Bay to Tijuana Estuary)

Family name	Common name	Scientific name
Finfish Species		
Serranidae	Kelp bass	*Paralabrax clathratus*
	Barred sand bass	*Paralabrax nebulifer*
Sciaenidae	White croaker	*Genyonemus lineatus*
	Corbina	*Menticirrhus undulatus*
Embiotocidae	Black perch	*Embiotoca jacksoni*
	Walleye surf perch	*Hyperprosopan argenteum*
	Barred surf perch	*Amphistichus argenteus*
Scorpaenidae	California scorpionfish	*Scorpaena guttata*
	Widow rockfish	*Sebastes entomelas*
	Blue rockfish	*Sebastes mystinus*
	Bocaccio	*Sebastes paucispinis*
Pleuronectidae	Diamond turbot	*Hypsopetta guttulata*
	Dover sole	*Microstomus pacificus*
Shellfish Species		
Bivalves	Blue mussel	*Mytilus edulis*
	California mussel	*Mytilus californianus*
	Pacific littleneck clam	*Protothaca staminea*
Crustaceans	Pacific rock crab	*Cancer antennarius*
	Red crab	*Cancer productus*
	California rock lobster	*Panulirus interruptus*