CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN DIEGO REGION

FINAL

REGIONAL BOARD REPORT
SHIPYARD SEDIMENT CLEANUP LEVELS
NASSCO & SOUTHWEST MARINE SHIPYARDS
SAN DIEGO BAY

February 16, 2001

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Appendices

LIST OF ACRONYMS

AET	Apparent Effects Threshold
BCF	Bioconcentration Factor
BPTCP	Bay Protection and Toxic Cleanup Program
CAO	Cleanup and Abatement Order
CTR	California Toxics Rule
ERM	Effects Range Median
HHC	Human Health Criteria
MAR	Marine Habitat Beneficial Use
NASSCO	National Steel and Shipbuilding Company
NOAA	Nation Oceanic and Atmospheric Administration
PAHs	Polynuclear Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PCTs	Polychlorinated Terphenyls
SDCDHS	San Diego County Department of Health Services
TBT	Tributyltin
WDR	Waste Discharge Requirements

EXECUTIVE SUMMARY

Issue

National Steel and Shipbuilding Company (NASSCO), Southwest Marine, Inc. (Southwest Marine) and Campbell Industries Marine Construction and Design Company (Campbell Industries) are shipyards located along the northeast side of San Diego Bay. Shelter Island Boatyard is located in America's Cup Harbor in San Diego Bay.

Elevated levels of pollutants exist in the bay bottom sediment adjacent to NASSCO and Southwest Marine. The concentration of these pollutants causes or threatens to cause a condition of pollution that harms the beneficial uses designated for San Diego Bay. NASSCO and Southwest Marine have performed assessment activities to delineate the extent of pollutants adjacent to their facilities. The Regional Board has given preliminary approval to use the sediment cleanup levels derived from Campbell Shipyard and Shelter Island Boatyard for NASSCO and Southwest Marine.

The Regional Board must establish final sediment cleanup levels for NASSCO and Southwest Marine in accordance with 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 provides in Section III.G that cleanup levels must ensure the"… attainment of either background water quality, or the best water quality, which is reasonable if background levels of water quality cannot be restored, considering all demands being made and to be made on those waters and the total values involved, beneficial and detrimental, economic and social, tangible and intangible…".

History

In January 1991, Regional Board staff requested NASSCO and Southwest Marine to participate in a sediment study to determine if sediment cleanup was required within their bay leasehold. From October 1994 to present, NASSCO and Southwest Marine have been actively working with Regional Board staff to assess and cleanup contaminated bay sediments.

In an August 3, 1995 letter, the Regional Board Executive Officer directed the shipyards to conduct a detailed site-specific analysis conforming to the Regional Board document titled "*Sediment Assessment Criteria"* to determine sediment cleanup levels. NASSCO and Southwest Marine noted that the cost of the required sediment assessment was excessive. Subsequent to the August 3 letter, the use of marine sediment studies conducted at Campbell Shipyard was determined to be potentially suitable for cleanup levels at NASSCO and Southwest Marine. NASSCO and Southwest Marine began

working with the Regional Board to determine the nature and extent of contaminated sediments within their bay leasehold that required cleanup. The site assessments were directed towards determining the extent of sediments containing pollutants exceeding the Campbell Shipyard Apparent Effects Threshold (AET) cleanup levels.

Basis for Interim Cleanup Levels

In March 1999, the Regional Board adopted Resolutions 99-12 and 99-20. These resolutions established the interim use of cleanup levels derived from marine sediment studies conducted at Campbell Shipyard and Shelter Island Boatyard at NASSCO and Southwest Marine. The Resolutions were adopted on an interim basis to encourage the immediate process of dredging contaminated sediments within the NASSCO and Southwest Marine bay leaseholds. The Board also directed staff to send out the February 17, 1999 staff report (Establishment of Shipyard Sediment Cleanup Levels for NASSCO and Southwest Marine) on the interim cleanup levels to a peer review panel to assist in determining if the cleanup levels should be adopted as final cleanup levels.

The interim sediment cleanup levels for NASSCO and Southwest Marine, as adopted by the Regional Board in Resolution Nos. 99-12 and 99-20, are based on the previously established cleanup levels for Campbell Shipyard (copper, zinc, lead, and PCBs) and Shelter Island Boatyard (mercury). These sediment cleanup levels were developed using the Apparent Effects Threshold (AET) approach.

The removal of sediments under the March 1999 interim cleanup levels has not occurred. The shipyards do not want to duplicate an effort of mobilizing resources for an interim cleanup and then again for a final cleanup.

Peer Review Panel

As a follow-up to the March 10, 1999 Regional Board meeting, the Executive Officer sent a letter on December 15, 1999 to three candidates nominated for an informal peer review due to their professional experience and reputation concerning bay sediment analysis, and benthic chemistry and toxicity. The objective of the informal peer review was to consider the scientific validity of using the sediment cleanup levels (based on the AET approach) derived for Campbell shipyards at NASSCO and Southwest Marine. The peer review panel was instructed by Regional Board staff to not include Shelter Island Boatyard as part of their assessment. The peer review panel consists of Mr. Steven Bay of Southern California Coastal Water Research Project, Mr. Russell Fairey of Moss Landing Marine Laboratories, and Mr. Todd Thornburg of Hart Crowser, Inc.

Regional Board Peer Review Follow-Up

Earlier this year the Regional Board received three reports from the peer review panel discussing the use of interim levels as final cleanup levels. There are some statements in

the peer review reports that staff agrees with and others that staff disagrees with. The peer review comments are addressed in detail in the staff report.

Evaluation of Most Sensitive Beneficial Use

A fundamental step in the development of cleanup levels is the identification of the most sensitive beneficial use to be protected. The Regional Board is making the assumption that the benthic community covered under the marine habitat beneficial use (MAR) represents the most sensitive beneficial use needing protection from contaminated sediment at NASSCO and Southwest Marine shipyards. This assumption is based on the intimate contact and long duration of contact (in some cases entire life cycles). The Regional Board also recognizes that there is a potential threat to human health through three principal pathways of exposure. The primary and by far the most significant being the consumption of fish and shellfish contaminated by chemicals in the sediment through the processes of bioaccumulation and biomagnification.

Cleanup Level Options

Regional Board staff has considered six options for establishing final sediment cleanup levels at NASSCO and Southwest Marine. The six options consist of the following:

- Option 1 – Background Reference Station
- Option 2 – Effects Range Median
- Option 3 – Campbell Shipyard & Shelter Island Boatyard AET Levels – 20% Safety Factor (Pre-Sampling Program)
- Option 4 - Campbell Shipyard & Shelter Island Boatyard AET Levels (Pre-Sampling Program)
- Option 5 – Site-Specific AET Levels (Comprehensive Chemical Analysis)
- Option 6 – No Action

Each option was evaluated based on the degree of environmental protection provided by the cleanup levels, costs associated with cleanup activities, dredge volume, percentage of leasehold dredged, pros/cons associated with dredging to the respective cleanup levels, and the outcome for selecting each proposed option.

Tables 1 and 2 outline six cleanup options at NASSCO and Southwest Marine for consideration by the Regional Board. Options 1 through 4 entail Regional Board adoption of specific cleanup levels (see Figure 1). Under Option 5, the Regional Board would require a detailed site-specific analysis to determine cleanup levels at a future date. Option 6 is a no-action alternative where the contaminated sediments would be left in place. The cost of the cleanup options varies from approximately $1.7 to $29 million at each site. The options are evaluated in detail in the attached staff report.

Regional Board Public Hearing

At the October 11, 2000 Regional Board meeting, the Regional Board received public comments and testimony regarding the selection of sediment cleanup levels at NASSCO and Southwest Marine shipyards. Staff presented the six cleanup options contained in this report for consideration by the Regional Board.

At the conclusion of the October 11 hearing the Regional Board elected to extend the time for submission of written comments from the public to October 19, 2000. Following the October 11 Board meeting staff received an October 16, 2000 letter from Mr. David L. Mulliken, legal counsel for NASSCO and Southwest Marine, requesting that the deadline for submission of written comments be further extended to a date three weeks following receipt of the written transcript of the October 11 Board meeting. Mr. Mulliken requested the extension to allow NASSCO and Southwest Marine sufficient time to provide meaningful comments on the various issues raised at the October 11 Regional Board meeting. Based on this consideration, Mr. John Robertus, Executive Officer, extended the deadline for submission of written comments from interested persons to November 8, 2000.

Public Comments

The Regional Board received a considerable volume of written comments from interested persons by the November 8 deadline. The Regional Board's written response to these comments is in a February 16, 2001, report titled "Response to Comments, Shipyard Sediment Cleanup Levels, NASSCO & Southwest Marine Shipyards, San Diego Bay".

The positions of the various interested parties who submitted comments on this issue are summarized below.

- NASSCO and Southwest Marine Shipyards:

1. Governing legal standards allow RWQCB approval of an AET-based clean-up standard and do not compel adoption of a background standard.
2. Water Code Section 13304 and Resolution 92-49 directly relate to water quality standards, not sediment contamination/ cleanup resulting from past discharges.
3. Neither statutes nor regulations mandate background level clean up of sediments, and both contemplate consideration of cost-effectiveness.
4. Requiring clean-up to background would set unwarranted precedent
5. Clean up to background has not been investigated and therefore cannot be imposed.
6. Good science supports use of the AET-based cleanup standard; No scientific support exists to support application of a background standard to sediment cleanup.
7. Imposition of a background cleanup standard to sediment dredging of the shipyard's facilities may have significant operation impacts on the shipyards.

8. Economic considerations weigh heavily in favor of the use of the AET based approach to sediment cleanup.
9. Past precedent, fundamental fairness and the benefits of expeditious implementation of sediment remediation all support use of the AET approach.

- San Diego BayKeeper and the Environmental Health Coalition:

  San Diego BayKeeper and the Environmental Health Coalition urge the Regional Board to adopt Option 1 – Background Reference Levels as the sediment cleanup levels for NASSCO and Southwest Marine for the following reasons:

1. Option 1 will allow NASSCO and Southwest Marine to remediate the contamination they are responsible for.
2. State Board Resolution No. 92-49 requires dischargers to cleanup to background levels unless background levels are not attainable. There is not evidence showing why background levels are not technically and economically feasible at the shipyards.
3. The other alternatives (Campbell AET, Campbell AET + 20%, and ERMs) considered by staff are flawed and will not sufficiently provide the protection of beneficial uses and public health.

Final Recommendation

Staff recommends that the Regional Board direct the Executive Officer to issue Water Code Section 13267 letters to NASSCO and Southwest Marine requiring the submission of a site-specific study to develop sediment cleanup levels and identify sediment cleanup alternatives. The Site Specific Study should include at a minimum the information described below.

- Site Specific Study to Develop Cleanup Levels

1. NASSCO and Southwest Marine shall submit a work plan and time schedule to complete a site assessment; develop sediment cleanup levels, including an adequate margin of safety, for constituents of concern identified through on-site chemical screening

2. NASSCO and Southwest Marine shall develop cleanup alternatives with projected cleanup costs.

3. NASSCO and Southwest Marine shall determine cleanup level(s) through scientifically defensible methods and designed to provide adequate protection for the most sensitive beneficial use of San Diego Bay. This requires that an extremely broad group of organisms that are affected by water quality conditions be considered. These include benthic (living in sediments) and epibenthic (living on the surface of sediments) organisms, organisms living in the water, waterfowl and shorebirds, and terrestrial animals (including humans) which eat aquatic organisms.

4. NASSCO and Southwest Marine shall determine cleanup levels for each constituent of concern by several complimentary methods as determined by Regional Board staff. There is no single method that measures the effects of contaminated sediments at all times and to all organisms. The selection of complementary allow for the integration of empirical data developed for Apparent Effects Thresholds (AET), theoretical information used in Equilibrium Partitioning (EqP), and cause and effect relationships established by spiked bioassays. The methods used to determine cleanup levels shall at minimum include the following:

    a) Equilibrium Partitioning (EqP) Approach – Cleanup levels will be established at chemical concentrations in sediment that ensure interstitial water concentrations do not exceed adopted water quality objectives or USEPA water quality criteria (in the absence of adopted water quality objectives)

    b) Apparent Effects Threshold - The Apparent Effects Threshold (AET) approach is the sediment concentration of a contaminant above which statistically significant biological effects (e.g. amphipod mortality in bioassays, depressions in the

abundance of benthic infauna) would always be expected. The method applies the triad of chemical, toxicological, and benthic community field survey measures to determine a concentration in sediments above which adverse effects are always expected.

c) Spiked Sediment Toxicity – Dose response measurements are established by exposing test organisms to sediments that have been spiked with known amounts of chemicals or mixtures of chemicals.

4. NASSCO and Southwest Marine shall access the potential health risk to humans from exposure to pollutants through the food chain attributable to the contaminated sediment. If preliminary screening indicates an unacceptable risk to human health, a detailed human health risk assessment shall be conducted.

5. NASSCO and Southwest Marine shall submit other additional information on cleanup costs, alternatives and methods as determined by Regional board staff. In determining this information staff will review and update the August 3, 1995 letter in Appendix F, from the Regional Board to NASSCO and Southwest Marine describing the minimum criteria for contaminated sediment assessment.

Based on the information provided by NASSCO and Southwest Marine staff will develop specific cleanup recommendations for sediment cleanup levels at NASSCO and Southwest Marine and bring the matter back for Regional Board consideration at a future date.

INSERT TABLE 1

INSERT TABLE 2

INSERT FIGURE 1

ISSUE

Elevated levels of pollutants exist in the bay bottom sediment adjacent to several shipyards in San Diego Bay. The concentration of these pollutants causes or threatens to cause a condition of pollution that harms the beneficial uses designated for San Diego Bay. National Steel and Shipbuilding Company (NASSCO) and Southwest Marine, Inc. (Southwest Marine) have performed assessment activities to delineate the extent of pollutants adjacent to their facilities. The Regional Board has given preliminary approval to use the sediment cleanup levels derived from Campbell Shipyard and Shelter Island Boatyard for NASSCO and Southwest Marine.

The Regional Board must establish final sediment cleanup levels for NASSCO and Southwest Marine in accordance with 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 provides in Section III.G that cleanup levels must ensure the"… attainment of either background water quality, or the best water quality, which is reasonable if background levels of water quality cannot be restored, considering all demands being made and to be made on those waters and the total values involved, beneficial and detrimental, economic and social, tangible and intangible…"

HISTORY

In January 1991, Regional Board staff requested NASSCO and Southwest Marine to participate in a sediment study to determine if sediment cleanup was required within their bay leasehold. From October 1994 to present, NASSCO and Southwest Marine have been actively working with Regional Board staff to assess and cleanup contaminated[1] bay sediments.

I. NASSCO

Site Location/Plan

NASSCO is located along the eastern shore of San Diego Bay at 28th Street and Harbor Drive in San Diego, California. NASSCO's primary business has historically been ship repair, construction, and maintenance capabilities for the U.S. Navy and commercial customers. The facility covers approximately 127 acres of tidelands property leased from the San Diego Unified Port District. The land portion and offshore area of the lease includes approximately 80 acres and 47 acres, respectively. Site improvements include offices, shops, warehouses, concrete

[1]The term contaminated sediment, as used in this report, is defined as sediments that contain chemical concentrations above background reference concentrations.

platens for steel fabrication, a floating dry dock, a graving dock, two shipbuilding ways, and 12 berths.

Site Investigations

In February and March 1997, the Regional Board required NASSCO to conduct sediment investigations adjacent to their facility for elevated concentrations of copper, zinc, and mercury. These indicator chemicals were selected based on the chemicals of concern for Campbell Shipyard, NASSCO's NPDES monitoring program, and the Bay Protection and Toxic Cleanup Program (BPTCP) (six stations within NASSCO's leasehold). Four remediation areas were identified which contained copper, zinc, and mercury concentrations that exceeded the Campbell Shipyard and Shelter Island Boatyard cleanup levels. These remediation areas are located within NASSCO's inner leasehold. Generally, concentrations decrease when moving away from the four identified areas of concern.

II. Southwest Marine

Site Location/Plan

Southwest Marine is located along the eastern shore of San Diego Bay, at the foot of Sampson Street in San Diego, California. Southwest Marine's primary business has historically been ship repair and maintenance capabilities for the U.S. Navy and commercial customers. The facility covers approximately 27 acres of tidelands property leased from the San Diego Unified Port District. The land portion and offshore area of the lease includes approximately 10 acres and 17 acres, respectively. Site improvements include offices, shops, warehouses, two floating dry docks, two marine railways, and five piers.

Site Investigations

In October 1997 and April 1998, the Regional Board required Southwest Marine to conduct sediment investigations adjacent to their facility for elevated concentrations of copper, lead, mercury, zinc, and PCBs. These indicator chemicals were selected based on the chemicals of concern for Campbell Shipyard, Southwest Marine's NPDES monitoring program, and the BPTCP (six stations within Southwest Marine's leasehold). Five remediation areas were identified which contained copper, lead, mercury, zinc, and PCB concentrations that exceeded the Campbell Shipyard and Shelter Island Boatyard cleanup levels. These remediation areas are located within Southwest Marine's inner leasehold. Generally, concentrations decrease when moving away from the five identified areas of concern.

III. Timeline

The objectives of the timeline are to provide a historical background of NASSCO's and Southwest Marine's effort towards the delineation and remediation of waste discharges within their bay leaseholds and to summarize Regional Board activities.

- November & December 1990
  Regional Board staff held individual **meetings** with NASSCO, Southwest Marine, and Continental Maritime (collectively termed the "Shipyards") to discuss the results of the sediment data collected by the Regional Board in 1988.

- January 10, 1991
  Regional Board **letter** to the Shipyards requesting the shipyards to conduct a sediment study to determine if sediment cleanup is required within their bay leasehold.

- March 1, 1991
  Regional Board **letter** to the shipyards granting the extension of the sediment studies requested by the Shipyards.

- April 1, 1991
  Southwest Marine **letter** to Regional Board indicating that a sediment study is not necessary for Southwest Marine.

- July 19, 1991
  Regional Board **letter** to the Southwest Marine indicating that a sediment study is necessary for Southwest Marine.

- September 3, 1991
  Regional Board staff had a **meeting** with the Shipyards to discuss the request to not conduct sediment studies.

- September 17, 1991
  NASSCO **letter** to Regional Board discussing the agreement that the Shipyards will act as a group and cooperate, cooperate with the Regional Board, and develop an approach for the sediment studies.

- October 17, 1991
  Shipyards **letter** to Regional Board detailing the approach outline for the sediment study.

- October 19, 1994

Regional Board **letter** to the Shipyards accepting the approach outline for the sediment study.

- November 2, 1994
  Shipyards **letter** to Regional Board requesting a postponement of the sediment study until February 1995 to allow the Shipyards time to assimilate changed circumstances (personnel and management).

- April 7, 1995
  Shipyards **letter** to Regional Board discussing the technical approach for the sediment study.

- June 8, 1995
  At the Regional Board **meeting,** the Regional Board affirmed the issuance of Cleanup and Abatement Order No. 95-21 to Campbell Industries by the Executive Officer on May 24, 1995.

- August 3, 1995
  Regional Board **letter** to the Shipyards discussing detailed written guidelines to perform a complete site assessment and develop alternate cleanup strategies.

- November 1, 1995
  Shipyards **letter** to Regional Board discussing the participation of the Shipyards in the bay wide approach and requesting a delay in proceeding with the site assessments. Discussions between the Shipyards have left only NASSCO as an active participant in the bay wide approach.

- November 9, 1995
  At the Regional Board **meeting,** the Regional Board discussed sediment cleanup and postponed a decision until the next meeting.

- December 14, 1995
  At the Regional Board **meeting** the Board agreed with the option of performing cleanup activities immediately (i.e., dredging) and subsequently conduct a post sampling effort. There was some discussion on the use of Campbell cleanup levels; however, the Board Members selected no cleanup levels at the meeting.

- August 1996
  Letters from NASSCO's consultant to the Regional Board discussing site assessment activities.

- February 14, 1997

Regional Board **letter** to NASSCO regarding sediment investigation requirements for elevated concentrations of copper and zinc. Sediment investigations were required to determine the areal extent and location of sediments containing chemical concentrations in excess of the Campbell Shipyard and the Shelter Island Boatyard cleanup levels.

- October 22, 1997
  Regional Board **letter** to Southwest Marine regarding sediment investigation requirements for elevated concentrations of copper, zinc, lead, and mercury. Sediment investigations were required to determine the areal extent and location of sediments containing chemical concentrations in excess of the Campbell Shipyard and the Shelter Island Boatyard cleanup levels.

- March 11, 1998
  At a staff **meeting**, Regional Board directed NASSCO to also investigate mercury at a small area of NASSCO's leasehold just east of the floating drydock near shore.

- April 27, 1998
  Regional Board **letter** to Southwest Marine directing Southwest Marine to also investigate PCBs in the sediment.

- March 10, 1999
  At the Regional Board **meeting,** the Regional Board adopted Resolution No. 99-12 establishing interim sediment cleanup levels for Southwest Marine, WDR Order No. 99-14 establishing dredging requirements for Southwest Marine, and Resolution No. 99-20 establishing interim sediment cleanup levels for NASSCO. Resolution No. 99-12 and Resolution No. 99-20 are provided in Appendix A. The Regional Board directed the Executive Officer to establish an informal peer review panel to determine the appropriateness of using the Campbell AET cleanup levels at the other two shipyards as interim cleanup levels.

- December 1999
  Peer Review Started

- March 2000
  Results of Peer Review

- June 2, 2000
  A **workshop** was held at the Regional Board office to discuss the working draft Regional Board report.

- September 13, 2000
  At the Regional Board **meeting**, staff provided a status report for sediment investigation and cleanup at NASSCO and Southwest Marine.

- October 11, 2000
  At the Regional Board meeting, a public hearing was held for consideration of adopting final bay bottom sediment cleanup levels for NASSCO and Southwest Marine.

BASIS FOR INTERIM CLEANUP LEVELS

The interim sediment cleanup levels for NASSCO and Southwest Marine, as adopted by the Regional Board in Resolution Nos. 99-12 and 99-20, are based on the previously established cleanup levels for Campbell Shipyard (copper, zinc, lead, and PCBs) and Shelter Island Boatyard (mercury). These sediment cleanup levels were developed using the Apparent Effects Threshold (AET) approach.

I. Campbell Shipyard Cleanup Levels

Campbell Shipyard has been located on the northeastern shore of San Diego Bay since 1926. The Regional Board has regulated Campbell Shipyards for numerous years under an NPDES Permit (currently Order No. 97-36). Campbell Industries leased the Campbell Shipyards site from the San Diego Unified Port District. Historical site operations included the construction of commercial fishing vessels and the repair of naval ships. As a result of market changes, Campbell Industries has been focusing its attention on developing land uses compatible with those on the northwest boundary of the site, where public and commercial recreational areas already exist or are being developed. Currently, shipyard operations have ceased and existing structures have been removed and demolished.

Cleanup and Abatement Order (CAO) No. 95-21 was issued by the Executive Officer on May 24, 1995 and was adopted by the Regional Board on June 8, 1995. CAO No. 95-21 establishes soil, groundwater, and sediment cleanup levels for Campbell Shipyards. Furthermore, CAO No. 95-21 establishes a deadline date of June 1, 2000 for complete cleanup of soil containing wastes, polluted groundwater, and bay sediment containing wastes at the Campbell Shipyard site. Cleanup activities, however, have not begun at the site.

The sediment cleanup levels for Campbell Shipyard (dry weight) are as follows:

- Copper = 810 mg/kg
- Zinc = 820 mg/kg
- Lead = 231 mg/kg

- PCBs = 0.95 mg/kg

The sediment cleanup levels were derived from 15 stations at Campbell Shipyard using the AET approach. The AET approach uses observed relationships between biological data and chemical data to identify concentrations of chemicals in sediments that are expected (based on field evidence or theoretical predictions) to represent the threshold above which statistically significant biological effects are expected to occur. The AET sediment cleanup levels for Campbell Shipyard were established using four biological tests:

- 10-day amphipod mortality and reburial– *Rhepoxynius abronius.* Toxicity was determined using the following endpoints: (1) Primary endpoint - Percent amphipod mortality at the shipyard (Survival $\geq$ 75%) was significantly higher ($p \leq 0.05$) than the percent amphipod mortality at reference station REF-01 (REF-01 is located on the west side of San Diego Bay, near Silver Strand), and (2) Secondary endpoint – Percent reburial of surviving amphipods in clean sediment was significantly lower ($p \leq 0.05$) than the percent reburial of reference amphipods in clean sediment.
- Depression in total benthic infauna abundance (in-situ).
- Depression in amphipod abundance (in-situ).
- 20-day Juvenile polychaete growth and survival depression – *Neanthes arenaceodentata*. Toxicity was determined using the following endpoints: (1) Primary endpoint – Polychaete growth in the shipyard sediment was significantly lower ($p \leq 0.05$) than the growth at reference station REF-01, and (2) Secondary endpoint – Percent polychaete survival at the shipyard was significantly lower ($p \leq 0.05$) than the percent polychaete survival at reference station REF-01.

Each biological test identified an AET value for copper, zinc, lead, and PCBs. The AET values derived from each test represent the highest "no observed" effect level (i.e. highest chemical concentration at which no significant adverse biological effects were observed). The lowest AET values for copper, zinc, lead, and PCBs were then identified from the four tests and established as the sediment cleanup levels for Campbell Shipyard.

In addition to conducting the four biological tests, a bioaccumulation study was performed to assess the potential human health risks and environmental hazards posed by the Campbell shipyard sediments. Chemical concentrations in a shellfish, a crustacean, and several different species of fish were analyzed. Human health hazards were assessed by evaluating chemical concentrations in fish and shellfish from sites relative to the following: (1) Concentrations in fish and shellfish in other areas of San Diego Bay based on historical data, and (2) Guidelines derived from risk assessment models.

One demersal fish species (black croaker), two pelagic fish species (pacific mackerel and pacific sardine), mussels, and spiny lobsters were collected in the Campbell shipyard area. Muscle tissue from black croaker and spiny lobster, and wholebody samples of mackerel, sardines, and mussels were analyzed for the following constituents: nine metals (arsenic, cadmium, chromium, copper, lead, zinc, mercury, nickel, and silver), butyltin species, PCBs, and PCTs.

Based on the analytical results, concentrations of arsenic, mercury, butyltin species, and PCBs were detected in black croaker, mussels, and spiny lobster (PTI 1991). These concentrations exceeded theoretical, risk-based concentrations (developed by San Diego County Department of Health Services [SDCDHS]), which indicate potential levels of concern. Concentrations of all other chemicals that were detected in black croaker, mussels and lobster were below the risk-based concentrations. Although arsenic, mercury, butyltin species, and PCBs concentrations exceeded SDCDHS risk-based concentrations in a few cases, these concentrations were within the range of concentrations reported in demersal fish and shellfish collected from other locations in San Diego Bay. From the results presented in the Campbell Shipyard study, it appears that the health risks posed by Campbell Shipyards sediment to fish and shellfish is no greater than other locations within San Diego Bay.

II. Shelter Island Boatyard Cleanup Level

Shelter Island Boatyard is located at America's Cup Harbor in San Diego Bay. A sediment biological effects study somewhat similar to the Campbell Shipyard AET study was performed at Shelter Island Boatyard. Biological data from 11 stations were evaluated using two biological tests:

- 10-day amphipod mortality and reburial– *Rhepoxynius abronius.* Toxicity was determined using the following endpoints: (1) Primary endpoint - Percent amphipod mortality at the shipyard was significantly higher ($p \leq 0.05$) than the percent amphipod mortality in the control samples, and (2) Secondary endpoint – Percent reburial of surviving amphipods in clean sediment was significantly lower ($p \leq 0.05$) than the percent reburial of amphipods in the control samples.
- Depression in total benthic infauna abundance (in-situ).

Based on the results of the study, the highest mercury concentration detected in the Shelter Island Boatyard sediment was 4.2 mg/kg (dry weight). High amphipod survival and no depression in infaunal assemblage were observed at this concentration. Consequently, an AET mercury level of 4.2 mg/kg (dry weight) was developed for Shelter Island Boatyard.

III. NASSCO/Southwest Marine Interim Cleanup Levels

At the March 10, 1999 Regional Board meeting, Staff presented a report dated February 24, 1999 that recommended adoption of the cleanup levels based on using the cleanup levels developed for Campbell Shipyard (copper, zinc, lead, and PCBs) and Shelter Island Boatyard (mercury). Based on Staff's report and the public hearing, the Regional Board adopted Resolution No. 99-12, *A Resolution Establishing Interim Shipyard Sediment Cleanup Levels for Southwest Marine, Inc., San Diego County*, and Resolution No. 99-20, *A Resolution Establishing Interim Shipyard Sediment Cleanup Levels for NASSCO, San Diego County,* and directed the Executive Officer to establish an informal peer review panel to determine the appropriateness of using the Campbell AET cleanup levels at the other two shipyards.

The Regional Board found that the use of these interim cleanup levels at NASSCO and Southwest Marine were considered appropriate based on the following:

- Campbell Shipyard is located in San Diego Bay to the north of NASSCO and Southwest Marine (within 1-mile).
- Campbell Shipyard, NASSCO, and Southwest Marine are comparable in terms of site activities, waste materials, and matrices (i.e. paint blast material).
- Campbell Shipyard, NASSCO, and Southwest Marine are in the same hydrodynamic and biogeographic zones.
- Campbell Shipyard, NASSCO, and Southwest Marine are influenced by a similar suite of pollutants from off-site sources.
- Shelter Island Boatyard is similar to NASSCO and Southwest Marine in terms of site activities, waste materials, and matrices (i.e. paint blast material).
- Shelter Island Boatyard, NASSCO, and Southwest Marine are located in San Diego Bay.

PEER REVIEW PANEL

As a follow-up to the March 10, 1999 Regional Board meeting, the Executive Officer sent a letter on December 15, 1999 to three candidates nominated for an informal peer review due to their professional experience and reputation concerning bay sediment analysis, and benthic chemistry and toxicity. The objective of the informal peer review was to consider the scientific validity of using the sediment cleanup levels (based on the AET approach) derived for Campbell shipyards at NASSCO and Southwest Marine. The peer review panel was instructed by Regional Board staff to not include Shelter Island Boatyard as part of their assessment. The peer review panel consists of Mr. Steven Bay of Southern California Coastal Water Research Project, Mr. Russell Fairey of Moss Landing Marine Laboratories, and Mr. Todd Thornburg of Hart Crowser, Inc. The peer review reports from each panel member are provided in Appendix B.

I. Southern California Coastal Water Research Project

S. Bay stated that the AET cleanup values developed for Campbell Shipyard are not appropriate to apply at NASSCO and Southwest Marine. S. Bay's opinion is primarily based on two conclusions:

- Contamination patterns differ among the shipyard sites, which indicate that the relationship between adverse biological impacts and indicator chemicals may differ between sites.
- Insufficient data are available to support the assumption that the Campbell Shipyard AETs are sufficiently reliable to allow their application at other locations.

II. Moss Landing Marine Laboratories

R. Fairey stated that the AET cleanup values developed for Campbell Shipyard are not appropriate to apply at NASSCO and Southwest Marine. R. Fairey's opinion is primarily based on three conclusions:

- Data collected at Campbell Shipyard is insufficient and unsuitable for the application of the AET approach.
- Physical, chemical, and biological data are not similar enough among shipyards to apply AETs developed in one area to other areas.
- Cleanup levels developed using an AET approach do not provide the level of environmental protection necessary to meet management objectives in the management area.

III. Hart Crowser, Inc.

T. Thornburg stated that the AET cleanup values developed for Campbell Shipyard are appropriate to apply at NASSCO and Southwest Marine. T. Thornburg's opinion is primarily based on five conclusions:

- Campbell Shipyard, NASSCO, and Southwest Marine processes, discharges, and sediment characteristics are similar.
- Sediments at NASSCO and Southwest Marine exhibit relatively low toxicity based on the BPTCP.
- Campbell Shipyard AET values are consistent with sediment management standards.
- NASSCO and Southwest Marine are planning to dredge down to AET values, thereby providing long-term protection to San Diego Bay.
- Campbell Shipyard AET values will address a majority of site risks at NASSCO and Southwest Marine.

REGIONAL BOARD PEER REVIEW FOLLOW-UP

After reviewing the peer review reports, Regional Board staff decided to meet with each reviewer individually for further explanation and clarification of specific issues. In addition to meeting with the peer review panel, Mr. Tom Gries from Washington State Department of Ecology was consulted on the development and implementation of AETs for Puget Sound. The following are the issues considered and the conclusions made by Regional Board staff.

Issue: R. Fairey and S. Bay stated that 15 stations at Campbell Shipyard was not sufficient for developing AET cleanup levels.

Staff disagrees. The 15 stations are sufficient for developing AET cleanup levels at a single location such as Campbell Shipyard. In developing AET levels, it is suggested that a biased sampling plan should always be used when developing AET values, especially when using a small data set, to ensure that a wide range of contaminant concentrations is represented rather than a completely random sampling of the sediment. The 15 stations at Campbell Shipyard were strategically placed in locations throughout the leasehold in order to develop AET levels.

It was also noted that a minimum of 50 sampling locations with matched chemical and biological-effects data is necessary to establish reliable AET values. This is true for establishing "watershed-wide" or "region-wide" cleanup levels when using the AET approach.

Issue: It was noted in the follow-up meeting by S. Bay and R. Fairey, and conference calls with T. Gries, that the amphipod and polychaete tests are typically not as sensitive as other bioassays available in establishing AETs.

Staff agrees. The amphipod and polychaete solid phase (SP) or whole sediment tests used in the Campbell Shipyard study are standard bioassay tests that are widely used to determine toxic effects. It is suggested, however, that an additional test such as an echinoderm or bivalve development solid phase or suspended particulate phase test be conducted to develop more robust AET values. Both the echinoderm and bivalve tests are considered more sensitive to chemical contamination therefore these tests should give a more accurate AET.

The justification for an additional test is to assist in the decision process for developing an AET. The concern was that the amphipod or polychaete tests may produce inconclusive responses to sediment leaving the toxicity issue up for interpretation. With the additional test, a conclusion can be reached by the weight of the evidence of the tests.

Issue: S. Bay and R. Fairey questioned whether the physical, chemical, and biological characteristics are similar among the shipyards. T. Thornburg stated the three shipyard activities are very similar, within close proximity, and share the same watershed. He stated the shipyards "…share the same sedimentary and ecological environments within the bay."

Physical (grain size) and chemical data from the three shipyards NPDES monitoring program were compiled and statistically compared against one another using the Student's t-test to check for significant differences. Statistical analyses of the biological characteristics at the three shipyards were not conducted since biological data are currently not available for NASSCO and Southwest Marine. A summary of the grain size and chemical analyses are provided in Appendix C.

Based on the grain size results, no statistically significant differences could be found between the three shipyards. When comparing the grain size (fine and course sediment) from the NPDES monitoring programs, no significant differences were found when comparing Campbell Shipyard, Southwest Marine, and NASSCO.

Similar statistical comparisons were conducted using five metals (copper, zinc, mercury, lead and TBT) and five PAHs (pyrene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perlyene, and chrysene) from stormwater sediment data (1992-1999) using the Students t-test and NPDES (1992-2000) sediment data using a single factor analysis of variance test (ANOVA). Data used was from Campbell, NASSCO, and Southwest Marine shipyard monitoring reports. The results of the comparison are contained in following two tables. Table 3 is a comparison of stormwater sediment data from the three shipyards and Table 4 is a comparison of NPDES sediment data.

Table 3
Comparison of Stormwater Sediment Data from the Shipyards

Chemical	Comparison of Stormwater Data		
	Campbell vs NASSCO	**Campbell vs Southwest Marine**	**NASSCO vs Southwest Marine**
Copper		X	X
Zinc		X	X
Mercury			
Lead			
TBT			
Pyrene			
Benzo(a)pyrene			
Benzo(b)fluoranthene			
Benzo(ghi)perlyene			
Chrysene			
Total Number of Significant Differences	0	2	2
Percent Significantly Different	**0**	**20%**	**20%**
Average Percent Difference	**6.7%**	**Standard Deviation**	**11.5%**

X = Statistically significant difference observed between the two shipyards. alpha = 0.05.

The comparison of the stormwater data using a Students t-test showed few significant differences. Of the ten chemicals used in the comparison, only copper and zinc showed significant differences in the analysis of Campbell against Southwest Marine and NASSCO against Southwest Marine. No differences were observed in any of the ten chemicals when Campbell Shipyard data was compared against NASSCO.

Table 4
Comparison of NPDES Data from the Shipyards

Chemical	Comparison of NPDES Data		
	Campbell vs NASSCO	**Campbell vs Southwest Marine**	**NASSCO vs Southwest Marine**
Copper	X		X
Zinc	X	X	X
Mercury	X		X
Lead		X	
TBT	X		X
Pyrene	X	X	
Benzo(a)pyrene	X		X
Benzo(b)fluoranthene	X	X	X
Benzo(ghi)perlyene	X		X
Chrysene	X	X	
Total Number of Significant Differences	9	6	7
Percent Significantly Different	**90%**	**60%**	**70%**
Average Percent Difference	**73.3%**	**Standard Deviation**	**15.3%**

X = Statistically significant difference observed between the two shipyards. alpha = 0.05.

The comparison of the NPDES data using a single factor ANOVA from the three shipyards showed numerous significant differences. Overall, statistically significant differences were observed in 73.3 percent (22 of the 30) of the analyses. The analysis of the NPDES data implies that the composition of the three shipyard sediments may have enough differences to question whether the chemical compositions are similar. Because of the high percentages (60%-90%) of significant differences observed in the analyses, the use of Campbell Shipyard's AET values as sediment cleanup values at NASSCO and Southwest Marine may not be appropriate.

Issue: S. Bay and R. Fairey questions the protection of San Diego beneficial uses provided by the AET approach.

Staff disagrees. As discussed elsewhere in this report the Regional Board is making the assumption that the benthic community covered under the marine habitat beneficial use (MAR) represents the most sensitive beneficial use needing protection from contaminated sediment at NASSCO and Southwest Marine shipyards. Cleanup levels derived using the

AET Approach would provide for protection of the MAR.

A wide range of physical, chemical and biological factors influence the bioavailability of sediment contaminants and their potential to cause adverse biological effects on the benthic community. These factors include aquaeous solubility, pH, affinity for sediment organic carbon, sediment grain size, sediment mineral constituents (oxides of iron, manganese and aluminum), and the quantity of acid volatile sulfides in the sediment. The AET approach provides a relatively simple means of addressing the complexity of the biological-chemical interrelationships based on measures of sediment chemistry, sediment toxicity, and benthic community structure.

The overall objective of the AET approach is to measure sediment chemical constituents, sediment toxicity and adverse benthic community alterations; and then use the weight of evidence from these measurements to identify sediment contaminant concentrations which may cause adverse effects to the benthic community. The chemical data provides data on which chemicals are present in the sediment at the highest concentrations as well as potential sources. The sediment toxicity test provides direct evidence of adverse biological effects on test organisms. If the contaminants are toxic it can be assumed that the contaminants are bioavailable to the organisms. The sediment toxicity can also be used to determine the degree and nature of the toxicity. The analyses of the benthic community can be used to determine adverse effects to the diversity and abundance of the in-situ benthic community caused by the contaminant.

The AET is defined as the sediment concentration of a given chemical above which statistically significant biological effects are always observed in the sediment chemistry, sediment toxicity and benthic community data set used to generate the AET. For a 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 (although the exact chemical concentration where the effect would occur is not known.)

The AET approach has been used throughout the country as a basis for regulatory agency decisions on sediment cleanup and disposal at specific sites. The AET can serve as a viable basis for determining sediment cleanup levels because it can be used to predict where statistically significant biological effects are expected at a point with a known chemical concentration. Cleanup levels can be set either at the AET or to more stringent levels using a safety factor to account for uncertainties in the data or to ensure that other discharges in the vicinity do not cause the AET sediment contaminant values to be exceeded following the cleanup.

EVALUATION OF MOST SENSITIVE BENEFICIAL USE

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.

A fundamental step in the development of cleanup levels is the identification of the most sensitive beneficial use to be protected. The Regional Board is making the assumption that the benthic community covered under the marine habitat beneficial use (MAR) represents the most sensitive beneficial use needing protection from contaminated sediment at NASSCO and Southwest Marine shipyards. This assumption is based on the intimate contact and long duration of contact (in some cases entire life cycles). The Regional Board also recognizes that there is a potential threat to human health through three principal pathways of exposure. The primary and by far the most significant being the consumption of fish and shellfish contaminated by chemicals in the sediment through the processes of bioaccumulation and biomagnification.

The table below is derived from 40 CFR part 131, also known as the California Toxics Rule (CTR), and lists the numeric criteria established in the CTR that are protective for human health and saltwater organisms. The established human health criteria specifically take into account human health risks due to bioaccumulation.

Table 5
Establishment of Numeric Criteria for
Priority Toxic Pollutants for the State of California

Constituent	Protection of Organisms in Saltwater (µg/L)		Protection of Human Health (µg/L)	
	Acute	Chronic	Water and organism consumption	Organism consumption only
Copper	4.8	3.1	1300	*
Lead	210	8.1	*	*
Zinc	90	81	*	*
Mercury	[reserved]	[reserved]	0.050	0.051
PCB	*	0.03	0.00017	0.00017

(Source: 40 CFR Part 131; Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California)

* No promulgated criteria.

The table provides the maximum concentrations of a pollutant that can be found in the water without resulting in adverse effects. For example, no copper toxicity to saltwater organisms should occur if chronic copper concentrations in the saltwater are equal to or less than 3.1 micrograms per liter (µg/L). Further, no adverse human effects should occur to humans drinking 2 liters a day of untreated water and eating 6.5 grams daily of fish or shellfish (see calculations below) from a source of water that has less than 1300 µg/L of copper.

The CTR established the human health criteria (HHC) using various equations. For example, to calculate the HHC for PCB when water and organisms are consumed, the following equation was used:

$$HHC = \frac{RF \times BW \times (1000\ \mu g/mg)}{q1^* \times [WC + (FC \times BCF)]}$$

Where: RF = Risk factor = 1×10^{-6}
BW = Body Weight = 70 kg
q1* = Cancer slope factor = 2 per mg/kg-day
WC = Water Consumption = 2L/day untreated surface water
FC = Total Fish and Shell Fish Consumption = 0.0065 kg/day
BCF = Bioconcentration Factor = 31,200

BCFs are used to relate pollutant residues in aquatic organisms to the pollutant concentration in ambient waters. For lipid soluble pollutants, the BCF is calculated from

the weighted average percent lipids in the edible portions of fish and shellfish, which is about 3%. For non-lipid soluble compounds, the BCF is determined empirically. As indicated by the CTR criteria, mercury and PCBs are significantly bioaccumulative, while zinc, copper, and lead are generally not significant bioaccumulators. Data, such as those from the US Department of Health, indicate that copper, lead, and zinc have BCFs that are typically lower than 300. PCB and mercury have high BCFs; the BCF is 31,200 for PCBs and 3,765 for mercury in estuarine coastal waters.

In addition to ingestion of organisms that have bioaccumulation of a pollutant, two other pathways of exposure to contaminated sediments are:

- Direct contact with contaminated sediments by swimmers or divers
- Incidental ingestion of contaminated sediment or associated water by swimmers or divers

However, available literature suggests that even when conservative assumptions about direct human exposure are used, risks associated with dermal contact and incidental ingestion of contaminated sediments are minimal and contribute less to the total risk than other pathways such as fish consumption.

As indicated by the CTR, Regional Board staff is aware that mercury and PCBs are significantly bioaccumulative; therefore, it is required that NASSCO and Southwest Marine conduct bioaccumulation tests to address human health risks. Mercury was identified as a chemical of concern at NASSCO, and mercury and PCBs were identified as chemical of concerns at Southwest Marine.

CLEANUP LEVEL OPTIONS

Regional Board staff has considered six options for establishing final sediment cleanup levels at NASSCO and Southwest Marine. The six options consist of the following:

- Option 1 – Background Reference Station
- Option 2 – Effects Range Median
- Option 3 – Campbell Shipyard & Shelter Island Boatyard AET Levels – 20% Safety Factor (Pre-Sampling Program)
- Option 4 - Campbell Shipyard & Shelter Island Boatyard AET Levels (Pre-Sampling Program)
- Option 5 – Site-Specific AET Levels (Comprehensive Chemical Analysis)
- Option 6 – No Action

Each option was evaluated based on the degree of environmental protection provided by the cleanup levels, costs associated with cleanup activities, dredge volume, percentage of

leasehold dredged, pros/cons associated with dredging to the respective cleanup levels, and the outcome for selecting each proposed option. The cleanup levels, dredge volume, percentage of leasehold dredged, and estimated costs for each option are summarized in Tables 1 and 2.

Regional Board Staff also considered four other cleanup level options prior to selecting the proposed six options. These cleanup level options were discussed in a staff report dated February 17, 1999 (Establishment of Shipyard Sediment Cleanup Levels for NASSCO and Southwest Marine) and is presented in Appendix D. The four options include the cleanup levels developed for the boatyards in America's Cup Harbor, Paco Terminals, Teledyne Ryan Aeronautical, and the Bay Protection and Toxic Cleanup Program.

I. Option 1 – Background Reference Station

Regional Board Staff considered the use of three reference stations (REF-01, REF-02, and REF-03) as the background reference station. These reference stations are designated as NPDES sampling locations for all shipyard and boatyard facilities located in San Diego Bay and are located in areas that would not be influenced by shipyard discharges. Reference station REF-01 is located on the west side of San Diego Bay off the Naval Ocean Systems Center pier, reference station REF-02 is located on the north side of San Diego Bay at the Cortez Marina in Harbor Island's west basin, and reference station REF-03 is located on the northeast side of San Diego Bay at the end on the Broadway pier.

Regional Board Staff conducted a statistical analysis using the Student's t-test to compare the sediment conditions from the three NPDES reference stations to the sediment conditions at NASSCO and Southwest Marine from urban runoff. Sediment conditions from urban runoff is evaluated on a yearly basis at NASSCO and Southwest Marine as required by the NPDES monitoring programs for the shipyards. Station NSS-STD-01 is sampled in the vicinity of stormdrain SW-9 and is located on the south side of the NASSCO facility near Chollas Creek. Station SWM-STD-01 is sampled in the vicinity of stormdrain SW-4 and is located near the bulkhead between Piers 3 and 4 at Southwest Marine.

The objective of the statistical analysis was to identify a reference station that most closely represents sediment conditions that would exist within the NASSCO and Southwest Marine leaseholds prior to waste discharges (per Resolution No. 92-49, *Policies and Procedures for Investigation and Cleanup and Abatement of Discharges under Water Code Section 13304*). The sediments in the vicinity of NPDES stations NSS-STD-01 and SWM-STD-01 are assumed to be mostly affected by watershed runoff and have minimal influence by shipyard discharges. The contaminants that were used in the statistical analysis consist of five metals

(copper, zinc, mercury, lead, and TBT) and five PAHs (pyrene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perlyene, and chrysene).

Based on the results of the statistical analysis, the sediment chemistry at reference station REF-03 had the least number of chemicals (3 of 10 chemicals) that were statistically different when compared to the sediment chemistry at NPDES stations NSS-STD-01 and SWM-STD-01. Consequently, REF-03 was selected as the background reference station. It should be noted that REF-03 was also selected as the background reference station for Campbell Shipyard. A summary of the statistical analysis is provided in Appendix E.

The sediment from reference station REF-03 is monitored on a semiannual basis as required by the NPDES permit for the shipyards. The results of 13 rounds of sediment sampling were used to calculate the weighted average background levels. Weighted averages were used to account for the historical data collected from the NPDES monitoring programs. Sediment data collected within 2 years were given twice the weight of data collected greater than 2 years. The background sediment levels are shown below.

Table 6
Background Cleanup Levels

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

Percentage of Leasehold Dredged & Cleanup Cost

Approximately 110% and 103% of the NASSCO and Southwest Marine leaseholds, respectively, will be dredged based on this option. The estimated costs associated with cleanup to background levels are $29,167,430 for NASSCO and $8,724,820 for Southwest Marine. It should be noted that NASSCO and Southwest Marine determined the percentage and cost estimates.

Pros and Cons

- Pros

  - All contaminated sediments will be removed. This represents 100% removal of pollutants discharged by NASSCO and Southwest Marine.
  - The sediment chemistry of the shipyard leaseholds is restored to pre-discharge conditions.
  - Provides high degree of assurance that pollutants discharged by NASSCO and Southwest Marine will no longer adversely affect marine organisms.
  - Presents highest degree of assurance that San Diego Bay beneficial uses are protected as compared to the other five options.
  - Level of cleanup very conservative in terms of protection of the marine environment.
  - Potential human health risk issues within the shipyards would be addressed by complete removal of contaminated sediment to background levels.

- Cons

  - Requires large volume of sediment removed including non-toxic sediment.
  - Established benthic communities will be removed or destroyed.
  - Largest volume of fine-grained sediment (potentially toxic) may be resuspended into the water column and likely settle into uncontaminated areas or into newly dredged areas.
  - Cost of the cleanup program is estimated to be very high as compared to the other cleanup level options that provide for protection of beneficial uses.

Outcome for Selecting Option 1

- Cleanup levels will immediately be established for NASSCO and Southwest Marine.
- No additional sediment studies will be required from NASSCO and Southwest Marine.
- Shipyards can proceed with cleanup of contaminated sediment.

II. Option 2 – Effects Range Median

The Effects Range Median (ERM) is the median of the total number of data points identified with adverse biological effects as developed from a national database compiled by the National Oceanic and Atmospheric Administration (NOAA). These data points are associated with chemical data and are ordered via increasing

concentrations. The database contains matched sediment chemistry and biological effects information generated from a variety of sediment quality approaches. The sediment quality approaches consist of the Equilibrium Partitioning approach, Spiked-Sediment Toxicity approach, Apparent Effects Threshold approach, Screening Level Concentration approach, and Sediment Quality Triad approach. Additionally, to maximize the broad applicability of the ERM, a wide variety of measures of adverse biological effects were included. The types of biological effects consist of the following:

- Measures of altered benthic communities (depressed species richness or total abundance), significantly or relatively elevated sediment toxicity, or histopathological disorders in demersal fish observed in field studies;
- EC_{50} (effective concentration – 50% adverse effects of test organisms) or LC_{50} (lethal concentration - 50% survival of test organisms) concentrations determined in laboratory bioassays of sediments spiked with single compounds or elements; and
- Toxicity predicted by equilibrium-partitioning models.

The probability of observing adverse biological effects in concentrations equivalent to or above the ERM is determined by the incidence of probable biological effects. The ERM for copper, zinc, lead, PCBs, and mercury are shown below including their respective incidence of effects.

Table 7
ERM Cleanup Levels

Constituent	ERM Dry Weight (mg/kg)	Incidence of Probable Biological Effects[(a)] (%)
Copper	270	84
Zinc	410	70
Lead	218	90
PCBs	0.18	51
Mercury	0.70	42

(a) Quantified as the number of cases in which effects were observed (at and above the ERM) divided by the total number of observations (at and above the ERM).

Percentage of Leasehold Dredged & Cleanup Cost

Approximately 62% and 100% of the NASSCO and Southwest Marine leaseholds, respectively, will be dredged based on this option. The estimated costs associated with cleanup to these levels are $17,299,530 for NASSCO and $8,508,845 for

Southwest Marine. It should be noted that NASSCO and Southwest Marine determined the percentage and cost estimates.

Pros and Cons

- Pros

  - In the absence of site-specific biological-effects data, the ERM identifies chemical concentrations in the sediment that may be toxic to marine organisms.
  - Dischargers do not have to collect biological-effects data within their leaseholds.
  - Chemical concentrations remaining in the sediment will be close to background levels as compared to the other five cleanup level options.

- Cons

  - As stated by NOAA, the ERM were not promulgated as regulatory criteria or standards. They were not intended as cleanup or remediation targets, nor as discharge attainment targets. Rather, they were intended as informal (non-regulatory) guidelines for use in interpreting chemical data from analyses of sediments.
  - No assurance that samples in which ERM values are exceeded will be toxic, therefore, the volume of sediment removed may include non-toxic sediments.
  - Established marine benthic communities may be removed or destroyed.
  - Cleanup levels were not developed based on site-specific data collected from the shipyards. The cleanup levels were established from a national database using different sediment quality approaches.
  - Large volume of fine-grained sediment (potentially toxic) may be resuspended into the water column and likely settle into uncontaminated areas or into newly dredged areas.
  - Human health risk issues will not be directly addressed since the ERM was not intended for use in predicting effects in wildlife or humans through bioaccumulation pathways.
  - Cost of the cleanup program is estimated to be high as compared to the other cleanup level options that provide for protection of beneficial uses.

Outcome for Selecting Option 2

- Cleanup levels will immediately be established for NASSCO and Southwest Marine.
- No additional sediment studies will be required from NASSCO and Southwest Marine.

- Shipyards can proceed with cleanup of contaminated sediments.

III. Option 3 – Campbell Shipyard & Shelter Island Boatyard AET Levels - 20% Safety Factor (Pre-Sampling Program)

This option consists of using the Campbell Shipyard and Shelter Island Boatyard AET levels with a 20% safety factor. The 20% safety factor was arbitrarily selected to provide a buffer on the AET cleanup levels. This safety factor will, to some extent, account for the uncertainties in the reliability of the use of these cleanup levels at NASSCO and Southwest Marine. The AET levels with the 20% safety factor are shown below.

Table 8
Campbell & Shelter Island Cleanup Levels with 20% Safety Factor

Constituent	AET with 20% Safety Factor Dry Weight (mg/kg)
Copper	648
Zinc	656
Lead	185
PCBs	0.76
Mercury	3.36

Due to the uncertainty of transferring the AET cleanup levels to NASSCO and Southwest Marine, as well as the arbitrary selection of the 20% safety factor, a pre-sampling program will be required. The pre-sampling program will consist of collecting biological confirmation samples near the boundaries of remediation areas identified by NASSCO and Southwest Marine. The remediation area boundaries shall be conservative delineations in that they shall be extended to areas with concentrations less than the Campbell Shipyard and Shelter Island Boatyard cleanup levels with the 20% safety factor.

Confirmation samples will be collected from each remediation area to confirm that adverse biological effects, as measured by sediment toxicity tests, are absent outside the areas delineated for remediation. If the confirmation samples pass the biological tests, the remediation areas shall be dredged and sediment samples will be subsequently collected from the dredged areas to confirm the complete removal of contaminated sediment exceeding the AET cleanup levels with the 20% safety factor. If the confirmation samples outside the remediation areas do not pass the biological tests; further site investigation will be required.

The confirmation samples will be analyzed using the biological tests conducted at Campbell Shipyard including an additional bioassay test (identified with an asterisk):

- Amphipod mortality and reburial
- Juvenile polychaete survival and growth depression
- Bivalve survival and growth depression*
- Total benthic infauna abundance
- Amphipod abundance
- Bioaccumulation study

A detailed discussion of these biological tests are provided in Option 5 (Site-Specific AET Levels – Comprehensive Chemical Analysis).

Percentage of Leasehold Dredged & Cleanup Cost

Approximately 13% and 18% of the NASSCO and Southwest Marine leaseholds, respectively, will be dredged based on the 20% safety factor. The estimated costs associated with cleanup to these levels including the pre-sampling program are $3,397,134 for NASSCO and $2,815,000 for Southwest Marine. It should be noted that NASSCO and Southwest Marine determined the percentage and cost estimates.

Pros and Cons

- Pros
  - Pre-sampling program will provide the assurance that the boundaries of the remediation areas are protective of San Diego Bay beneficial uses.
  - Toxic sediments will be removed based on cleanup levels developed from a shipyard within San Diego Bay (approximately 1-mile away).
  - Human health risk issues will be addressed by conducting the bioaccumulation study.
  - Use of a safety factor ensures a cleanup level below known adverse effect levels.
  - Moderate cost as compared to more stringent cleanup level options requiring removal of larger sediment volumes.

- Cons
  - Established benthic communities may be removed or destroyed (due to dredging activities).
  - Contaminated sediment left in-place may migrate to other areas of San Diego Bay.

Outcome for Selecting Option 3

- Pre-sampling will be required at NASSCO and Southwest Marine.
- If the results of the pre-sampling program confirm the absence of adverse biological effects outside the remediation areas, cleanup levels will immediately be established for NASSCO and Southwest Marine. Sediment cleanup can then proceed.
- If the results of the pre-sampling program do not confirm the absence of adverse biological effects outside the remediation areas, further site investigation activities will be required at NASSCO and Southwest Marine.

IV. Option 4 – Campbell Shipyard & Shelter Island Boatyard AET Levels (Pre-Sampling Program)

This option consists of conducting a pre-sampling program in order to transfer the Campbell Shipyard and Shelter Island Boatyard AET levels directly to NASSCO and Southwest Marine. The AET cleanup levels are shown below.

Table 9
Campbell & Shelter Island Cleanup Levels

Constituent	AET Dry Weight (mg/kg)
Copper	810
Zinc	820
Lead	231
PCBs	0.95
Mercury	4.2

Due to the uncertainty of transferring the AET cleanup levels to NASSCO and Southwest Marine, a pre-sampling program will be required. The pre-sampling program will consist of collecting biological confirmation samples near the boundaries of remediation areas identified by NASSCO and Southwest Marine. The remediation area boundaries shall be conservative delineations in that they shall be extended to areas with concentrations less than the Campbell Shipyard and Shelter Island Boatyard cleanup levels.

Confirmation samples will be collected from each remediation area to confirm that adverse biological effects, as measured by sediment toxicity tests, are absent outside the areas delineated for remediation. If the confirmation samples pass the biological tests, the remediation areas shall be dredged and sediment samples will be subsequently collected from the dredged areas to confirm the complete removal

of contaminated sediment exceeding the AET cleanup. If the confirmation samples outside the remediation areas do not pass the biological tests; further site investigation will be required.

The confirmation samples will be analyzed using the biological tests conducted at Campbell Shipyard including an additional bioassay test (identified with an asterisk):

- Amphipod mortality and reburial
- Juvenile polychaete survival and growth depression
- Total benthic infauna abundance
- Bivalve survival and growth depression*
- Amphipod abundance
- Bioaccumulation study

A detailed discussion of these biological tests are provided in Option 5 (Site-Specific AET Levels – Comprehensive Chemical Analysis).

Percentage of Leasehold Dredged & Cleanup Cost

Approximately 9% and 15% of the NASSCO and Southwest Marine leaseholds, respectively, will be dredged based on the AET levels developed for Campbell Shipyard and Shelter Island Boatyard. The estimated costs associated with cleanup to these levels including the pre-sampling program are $1,689,990 for NASSCO and $2,437,960 for Southwest Marine. It should be noted that NASSCO and Southwest Marine determined the percentage and cost estimates.

Pros and Cons

- Pros
  - Pre-sampling program will provide the assurance that the boundaries of the remediation areas are protective of San Diego Bay beneficial uses.
  - Toxic sediments will be removed based on cleanup levels developed from a shipyard within San Diego Bay (approximately 1-mile away).
  - Human health risk issues will be addressed by conducting the bioaccumulation study.

- Cons
  - Established benthic communities may be removed or destroyed (due to dredging activities).

- Lack of a safety factor does not provide a cushion for setting the cleanup levels below known adverse biological effect levels.

Outcome for Selecting Option 4

- Pre-sampling will be required at NASSCO and Southwest Marine.
- If the results of the pre-sampling program confirm the absence of adverse biological effects outside the remediation areas, cleanup levels will immediately be established for NASSCO and Southwest Marine and cleanup of contaminated sediments will occur.
- If the results of the pre-sampling program do not confirm the absence of adverse biological effects outside the remediation areas, further site investigation activities will be required at NASSCO and Southwest Marine.

V. Option 5 – Site-Specific AET Levels (Comprehensive Chemical Analysis)

Site-specific AET levels will be developed from a comprehensive evaluation of sediment chemistry at NASSCO and Southwest Marine. The evaluation will be somewhat similar to the Campbell AET study and will also incorporate specific criteria from the Shipyard Sediment Study requested by the Regional Board on August 3, 1995 (Appendix F).

The comprehensive evaluation will focus on the chemicals typically associated with shipyard activities, as well as other chemicals found in high concentrations in the vicinity of some shipyards in San Diego Bay. The major chemical groups that will be assessed include the following: metals, butyltin species, polycyclic aromatic hydrocarbons (low and high molecular weights), total PCBs, total polychlorinated terphenyls, and total petroleum hydrocarbons. Existing site-specific chemistry data (NPDES monitoring program and sediment investigations) will be compared to the sediment chemistry at reference station REF-03 and the ERM to assess the relative severity of sediment contamination and to identify candidate indicator chemicals. The selected indicator chemicals will then be used to generate site-specific AET values for NASSCO and Southwest Marine.

The site-specific AET values will be developed using the four tests conducted at Campbell Shipyard: amphipod mortality and burial (bioassay), total benthic infauna abundance, amphipod abundance, and juvenile polychaete survival and growth depression (bioassay). In order to develop more robust AET cleanup levels, the addition of a bivalve sediment toxicity test will be included. The addition of the bivalve sediment toxicity test will provide a bioassay with greater sensitivity to toxicity than the amphipod or polychaete test. The bivalve sediment toxicity test, using mussels (*Mytilus sp*), is a biologically relevant test species because mussels are found throughout San Diego Bay attached to pier piling, boat docks, and hard

substrate (jetty rocks). The alternate bivalve species to mussel will be the Pacific oyster, *Crassostrea gigas*.

The Campbell Shipyard AET study reported that some of the sediment toxicity observed in the amphipod test, using *Rhepoxynius abronius*, may have been due to grain size interferences. Previous studies have found *Rhepoxynius abronius* sensitive to sediments with high percentages of fine-grained sediment (silt and clay fractions). Due to these findings, the amphipod *Eohaustorius estuarius* will be used rather than the amphipod *Rhepoxynius abronius* since the amphipod *Eohaustorius estuarius* are tolerant to a wider grain size distribution. The reburial endpoint will be considered optional for the amphipod test.

In order to address potential human health risks due to sediment contaminant bioaccumulation, a sediment bioaccumulation test will also be added to the suite of biological tests. The addition of a 28-day bioaccumulation test will address possible chronic sublethal effects of contaminants in the marine sediment. Marine animals, typically a burrowing clam *(Macoma nasuta*) and/or a polychaete (*Neanthes arenaccodentata or Nereis virens*) are allowed to live in the sediment under laboratory test conditions for 28 days. The sublethal effects are the contaminants that the organisms accumulate in their tissue over the test duration. Mortality can also be used as an endpoint but this is usually a secondary endpoint. If the results of the bioaccumulation study determine that risks to human health exist, a model will be used to calculate sediment cleanup levels for the chemicals of concern.

Percentage of Leasehold Dredged & Cleanup Cost

The initial estimated costs associated with collecting and evaluating chemical, physical, and biological data (without dredge, disposal, and permit costs) are $1,074,490 for NASSCO and $989,000 for Southwest Marine. It should be noted that NASSCO and Southwest Marine determined the cost estimates.

Pros and Cons

- Pros
    - The comprehensive chemical analysis may identify additional indicator chemicals.
    - Toxic sediment will be removed based on site-specific chemical and biological effects data.
    - Removal of non-toxic sediments will be minimized.
    - Removal or destruction of established benthic communities will be minimized.

- Reasonable assurance that marine organisms and San Diego Bay beneficial uses will be protected.
- Resuspension and settling of fine-grained sediment (potentially toxic) into uncontaminated areas will be minimized.
- AET cleanup levels will be based on more recent chemical and biological effects data as compared to the approximate 10-year old data collected at Campbell Shipyard.
- Human health risk issues will be addressed by conducting the bioaccumulation study.

- Cons

  - Contaminated, non-toxic sediment will remain in-place.

Outcome for Selecting Option 5

- Site investigation activities will be required at NASSCO and Southwest Marine.
- Cleanup levels will be selected at a later Board Meeting based on the results of the site investigation.

VI. Option 6 – No Action

The no action option is a passive form of remedial action that allows natural recovery processes (i.e., sediment deposition) to provide a cap over areas exceeding cleanup levels. The cleanup levels for the no action option are based on data collected from the NPDES monitoring programs and the site assessments conducted within the NASSCO and Southwest Marine leaseholds. Weighted averages were used to evaluate and account for the historical data collected from the NPDES monitoring programs. Sediment data collected within 2 years were given twice the weight of data collected greater than 2 years. The weighted average concentrations were then combined with the site assessment data and ranked from highest to lowest concentration. Cleanup levels were determined by averaging the top 5% highest concentrations for each constituent. The no action cleanup levels for each shipyard are shown below.

Table 10
No Action Cleanup Levels

Constituent	NASSCO No Action Dry Weight (mg/kg)	Southwest Marine No Action Dry Weight (mg/kg)
Copper	1154	2,586
Zinc	1707	3,238
Lead	4286	560
PCBs	17.1	11.0
Mercury	3.36	20.7

An equation from a simple model, SEDCAM, was used to determine the estimated time for natural recovery processes to provide a 10-centimeter (cm) cap over areas exceeding the background reference sediment levels (Option 1). A 10-cm cap is considered to be a conservative and environmentally protective assumption under decreasing source loading. The equation, as derived from SEDCAM, is as follows:

$$C = [M/(M+kS)] \times C1 \times [1-\exp(-(ks+M)t)/S] + C0 \times [\exp(-(kS+M)t/S]$$

where: C1 = Concentration of contaminant in freshly-deposited material after source control (mg/kg)

C0 = Concentrations (ug/g) of contaminant in the surface mixed layer at t = 0

M = Rate of mass accumulation of solid material in the sediment after source control ($g/cm^2/yr$)

S = Total accumulation of sediment in the surface mixed layer (g/cm^2)

k = Combined first-order rate constant for contaminant loss by in-situ decay and diffusion processes (1/yr)

The assumptions made by SEDCAM include: (1) The ongoing (or predicted) source concentration is constant and known, (2) The initial chemical concentration in the surface sediment is known, (3) the sedimentation rate is known, (4) the mixed layer is a constant density and depth and is well mixed, (5) the rate of chemical transformation or loss is controlled by first-order processes, and (6) all rates are constant.

Based on the equation, the following table provides the number of years for each constituent to attain the 10-cm sediment cap at NASSCO and Southwest Marine.

Table 11
Number of Years for Sediment Cap

Constituent	NASSCO (years)	Southwest Marine (years)
Copper	70	79
Zinc	91	70
Lead	81	88
PCBs	50	47
Mercury	64	84

Percentage of Leasehold Dredged & Cleanup Cost

For cost comparison purposes of the six options, the costs associated with the no action option (i.e., monitoring of the sediment cap) were considered negligible and were not included.

Pros and Cons

- Pros
  - Resuspension and settling of fine-grained sediment (potentially toxic) into uncontaminated areas will not occur.
  - Established benthic communities will not be disturbed or destroyed.
  - No disruption in shipyard operations from dredging of contaminated sediment.
- Cons
  - No assimilative capacities of the shipyard leaseholds will be restored.
  - The estimated time for a sediment cap to be considered environmentally protective is not reasonable.
  - Exposure to contaminated sediment will persist until an environmentally protective cap is formed.
  - The navigational beneficial use would be affected due to the restrictions on maintenance dredging caused by the cap.
  - Human health risk issues will not be directly addressed.
  - Contaminants left in-place may migrate to other areas of San Diego Bay under conditions of resuspension, equilibrium partitioning, bioturbation, and advection.

Outcome for Selecting Option 6

The no action option is not considered a viable remedial alternative for NASSCO and Southwest Marine because it does not comply with 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*. This option does not cleanup the site since it only provides sediment coverage with no permanent containment or removal of pollutants. Additionally, since the shipyards are working shipyards there is a high potential for the sediment cap to be disturbed or dredged, resulting in the exposure of the remediation areas to the bay environment.

CONCLUSION

Staff recommends that the Regional Board adopt the recommendation described in the Executive Summary section of this report.