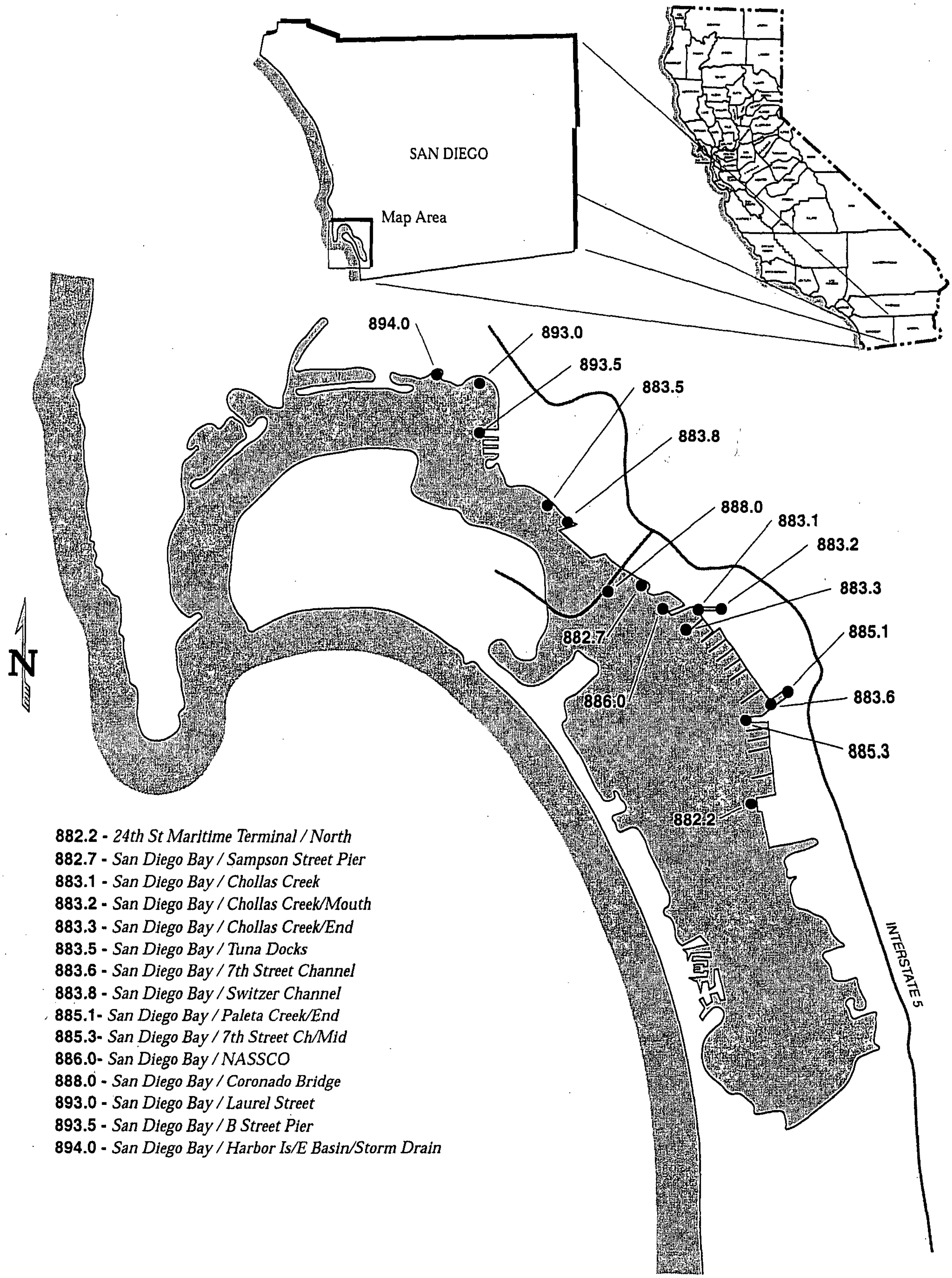
STATE MUSSEL WATCH 1995-97 SAMPLING STATIONS

San Diego Co. - San Diego Bay Area



882.2 - *24th St Maritime Terminal / North*
882.7 - *San Diego Bay / Sampson Street Pier*
883.1 - *San Diego Bay / Chollas Creek*
883.2 - *San Diego Bay / Chollas Creek/Mouth*
883.3 - *San Diego Bay / Chollas Creek/End*
883.5 - *San Diego Bay / Tuna Docks*
883.6 - *San Diego Bay / 7th Street Channel*
883.8 - *San Diego Bay / Switzer Channel*
885.1- *San Diego Bay / Paleta Creek/End*
885.3- *San Diego Bay / 7th Street Ch/Mid*
886.0- *San Diego Bay / NASSCO*
888.0 - *San Diego Bay / Coronado Bridge*
893.0 - *San Diego Bay / Laurel Street*
893.5 - *San Diego Bay / B Street Pier*
894.0 - *San Diego Bay / Harbor Is/E Basin/Storm Drain*

From: Pete Michael
To: Keri Cole
Date: 4/27/01 10:18AM
Subject: Re: Switzer Creek

Keri,
Yes, David is correct. The Year 1 and Year 2 sampling (FY 1992-93 and 1993-94) was supplemented by the third-year follow-up sampling when additional funds became available. In 1996, full triad sampling took place at Fish and Game's (Rusty's 1996 green cover Bay Protection report) "moderate priority" stations which had not previously been sampled for the full triad. Because the State Board "toxic hot spot" definitions called for repeat toxicity and chemistry hits or multiple degraded benthic communities with elevated chemistry, Switzer Creek did not become a toxic hot spot until the third year sampling. The data are in the tan cover 1998 addendum final report from Fish and Game.
If you would like to seed the RB agenda folder info, go to PROGRAMS, BAY PROTECTION on our website. Or talk to me.
Pete

>>> Keri Cole 04/27/01 09:17AM >>>
Good morning Pete
I dropped by a couple times on Wednesday and this morning to talk to you about Switzer Creek, but you've been busy on the phone.

I have some questions re: Switzer Creek in relation to the BPTCP and the 303d list of Impaired waters. We will most likely recommend adding Switzer Creek to the 303d list, based on some data that was gathered after the listing process last time which indicated degraded benthic communities. Do you know where I should look to get that data? David Barker indicated that it was subsequent to the 1996 BPTCP data and thus why it was not added to the 303d list in 1998. Can you help me out with this?

We are meeting with David Merk from the Port this morning to talk about site assessment and cleanup work in the Bay at both B Street Pier (currently listed) and Switzer Creek (not listed). Since the Shipyards and Navy will be doing similar work this year, it seems logical to get the Port going at the same time (to get comparable info, procedures, etc.).

Our meeting is at 10:30am this morning. Do you have a few minutes before then to talk with me? If not, I can catch you this afternoon.

Thanks.
Keri

CC: David Barker; Tom Alo

JHR - INFO

To:	Art Coe, David Barker, Bruce Posthumus	June 3, 1998
From:	Pete Michael	
Re:	New Bay Protection Data for San Diego Bay	

The report cited below is an addendum to the FY 1992-93 sampling project in the San Diego Bay. Additional sampling occurred at eight moderate-priority stations in December 1996. The eight stations had not previously been sampled for the entire triad consisting of toxicity, benthic community analysis, and chemistry.

In the addendum report only one station located at the mouth of the culvert at the north end of the Tenth Avenue Marine Terminal (Switzer Creek) was rated as high priority by Fish and Game. It remains to be seen whether additional toxic hot spots should be recommended. The toxic hot spot definitions are complex and the data has not yet been analyzed in detail.

The new data may have implications for the 303(d) list.

Chemistry, Toxicity, and Benthic Community Conditions in Sediments of the San Diego Bay Region; Addendum Report. May 1998

(From Table 5. Station Prioritization)

STATION	>4ERM OR >5.9PEL	ERMQ	PELQ	COMMENTS	PRIORITY
90039 Switzer Creek, Tenth Avenue Marine Terminal	Chlordane Lindane PAHs	2.142	3.785	Elevated chemistry, toxicity, degraded benthic community (but elevated H2S and TOC)	High
93178 Just north of Bridge	PCBs	1.372	1.875	Elevated chemistry, toxicity, transitional benthic community	Moderate
90022 Graving dock, Naval Station	PAHs	0.855	1.398	Elevated chemistry, toxicity, transitional benthic community	Moderate
90020 Just south of Bridge	PCBs	1.840	2.463	Elevated chemistry, degraded benthic community	Moderate
93179 Just south of Bridge	PCBs PAHs	1.545	2.227	Elevated chemistry, transitional community	Moderate
90007 Between Piers 3 and 4, Naval Station				Low chemistry, degraded community	Low
90008 Pier 6, Naval Station				Low chemistry, degraded community	Low
90013 Silver Strand				Low chemistry	No action

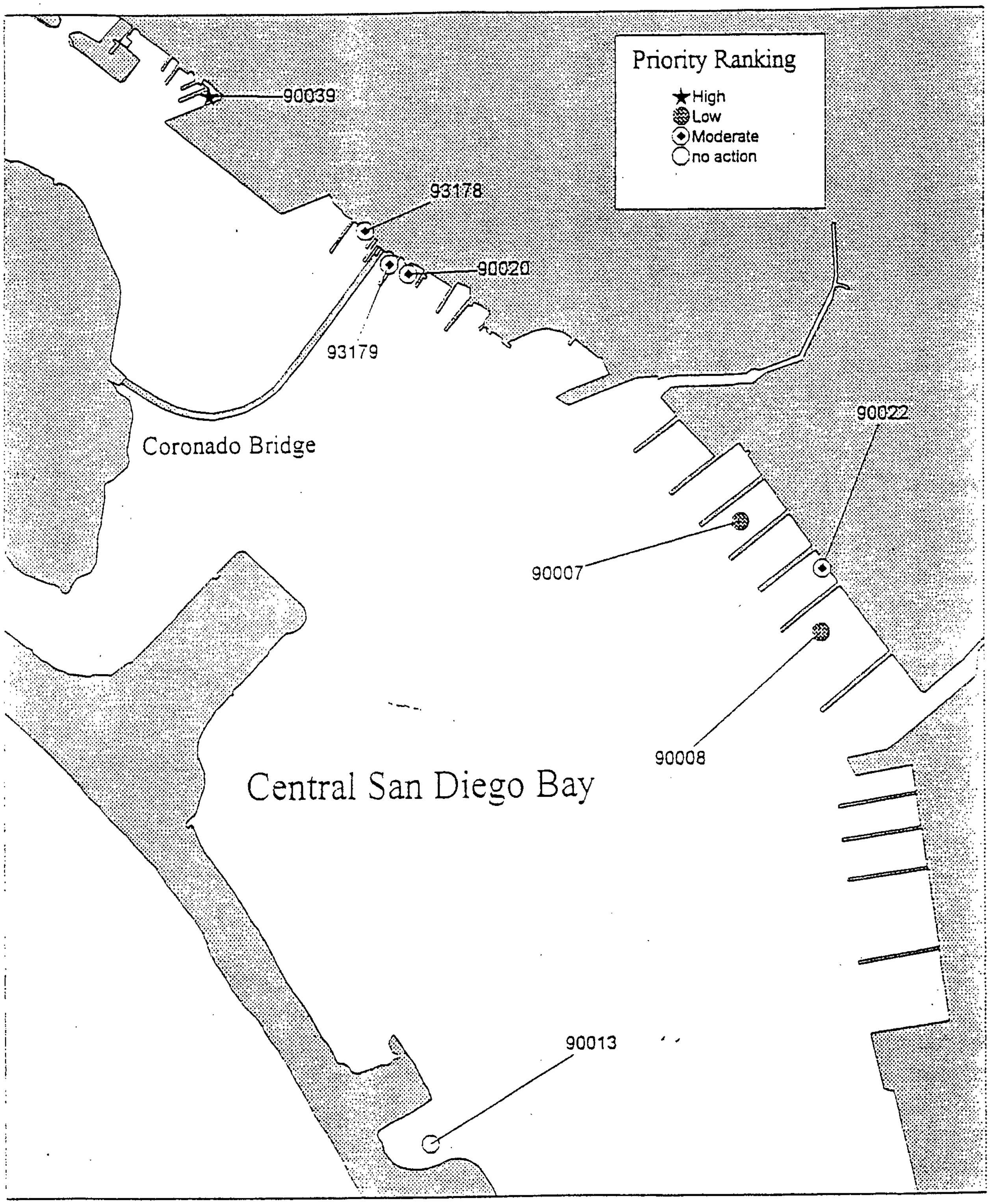
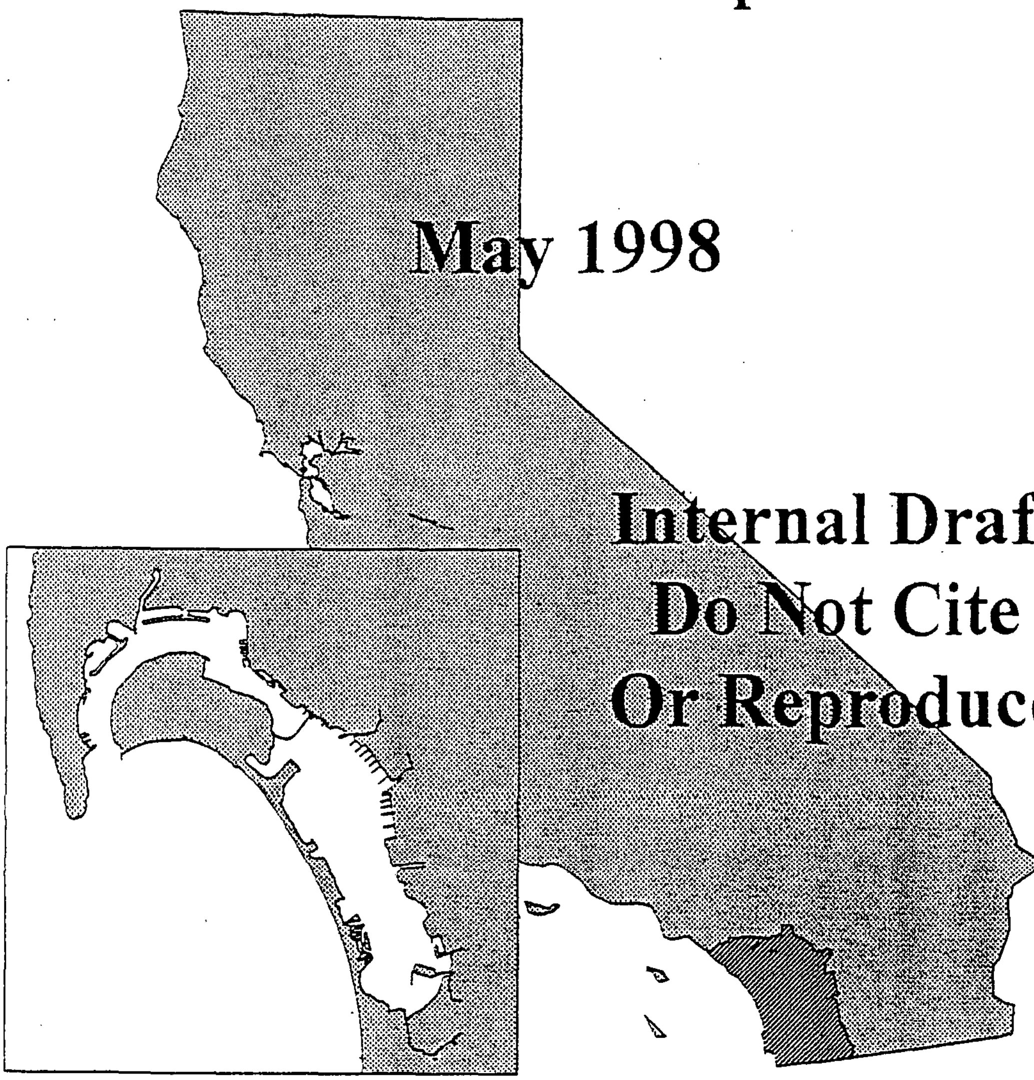


Figure 4. San Diego Bay region priority ranking for Addendum Report stations.

Chemistry, Toxicity, And Benthic Community Conditions In Sediments Of The San Diego Bay Region
Addendum Report



May 1998

Internal Draft
Do Not Cite
Or Reproduce

State Water Resources Control Board
California Department of Fish and Game
Moss Landing Marine Laboratories
University of California Santa Cruz

CHEMISTRY, TOXICITY AND BENTHIC COMMUNITY CONDITIONS IN SEDIMENTS OF THE SAN DIEGO BAY REGION

FINAL ADDENDUM REPORT

September 30, 1998

California State Water Resources Control Board

San Diego Regional Water Quality Control Board

California Department of Fish and Game
Marine Pollution Studies Laboratory

Moss Landing Marine Laboratories

University of California, Santa Cruz

AUTHORS

Russell Fairey, James Downing, Cassandra Roberts and Eli Landrau
San Jose State University- Moss Landing Marine Laboratories

John Hunt and Brian Anderson
University of California Santa Cruz

Craig J. Wilson, Gita Kapahi and Fred LaCaro
State Water Resources Control Board

Pete Michael
California Regional Water Quality Control Board- San Diego Region

Mark Stephenson and Max Puckett
California Department of Fish and Game

ACKNOWLEDGMENTS

This study was completed thanks to the efforts of the following institutions and individuals:

State Water Resources Control Board- Division of Water Quality
Bay Protection and Toxic Cleanup Program

Craig Wilson	Mike Reid	Fred LaCaro
Syed Ali	Gita Kapahi	

Regional Water Quality Control Board- Region 9

Pete Michael

California Department of Fish and Game
Environmental Services Division

Mark Stephenson	Max Puckett	Gary Ichikawa
Kim Paulson	Jon Goetzl	Mark Pranger

San Jose State University- Moss Landing Marine Laboratories

Sample Collection and Data Analysis

Russell Fairey	Cassandra Roberts	James Downing
Ross Clark	Michele Jacobi	Stewart Lamerdin
Eli Landrau		

Total Organic Carbon and Grain Size Analyses

Pat Iampietro	Bill Chevalier	Craig Hunter

Dissolved Organic Carbon Analysis
Steve Fitzwater

Benthic Community Analysis

John Oliver	Jim Oakden	Carrie Bretz
Peter Slattery		

ACKNOWLEDGMENTS (continued)

University of California at Santa Cruz

Dept. of Chemistry and Biochemistry- Trace Organic Analyses

Ronald Tjeerdema	John Newman	Debora Holstad
Katharine Semsar	Thomas Shyka	Gloria J. Blondina
Linda Hannigan	Laura Zirelli	James Derbin
Matthew Stoetling	Raina Scott	Dana Longo
Elise Gladish-Wilson	Jon Becker	

Institute of Marine Sciences- Toxicity Testing

John Hunt	Brian Anderson	Bryn Phillips
Witold Piekarski	Michelle White	Patty Nicely
Shirley Tudor	Matt Englund	

Funding was provided by:

State Water Resources Control Board- Division of Water Quality
Bay Protection and Toxic Cleanup Program

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

This addendum augments the report "Chemistry, Toxicity, and Benthic Community Conditions in Sediments of the San Diego Bay Region" submitted in September 1996 (Fairey *et al.*, 1996). This and the original study were conducted as part of the Bay Protection and Toxic Cleanup Program, a legislatively mandated program designed to assess the degree of chemical pollution and associated biological effects in California's bays, estuaries, and harbors.

The original study objectives were:

1. Determine presence or absence of adverse biological effects in representative areas of the San Diego Bay Region;

2. Determine relative degree or severity of adverse effects, and distinguish more severely impacted sediments from less severely impacted sediments;

3. Determine relative spatial extent of toxicant-associated effects in the San Diego Bay Region;

4. Determine relationships between toxicants and measures of effects in the San Diego Bay Region.

The research involved chemical analysis of sediments, benthic community analysis and toxicity testing of sediments and pore water. Chemical analyses and bioassays were performed using aliquots of homogenized sediment samples collected synoptically at each station. Analysis of the benthic community structure was made on a subset of the total number of stations sampled.

Summary of findings from original report

Three hundred fifty stations were sampled between October, 1992 and May, 1994. Areas sampled included San Diego Bay, Mission Bay, the San Diego River Estuary and the Tijuana River Estuary and collectively are termed "the San Diego Bay Region". Two types of sampling designs were utilized: directed point sampling and stratified random sampling.

Chemical pollution was compared to established sediment quality guidelines. Two sets of guidelines were used: the Effects Range-Low (ERL)/Effects Range-Median (ERM) guidelines developed by NOAA (Long and Morgan, 1990; Long *et al.*, 1995) and the Threshold Effects Level (TEL)/Probable Effects Level (PEL) guidelines used by the state of Florida (MacDonald, 1994). Copper, mercury, zinc, total chlordane, total PCBs and the PAHs most often were found to exceed critical ERM or PEL values and were considered the major chemicals or chemical groups of concern in the San Diego Bay Region. Chemical summary quotients were used to develop chemical indices for addressing the pollution of sediments with multiple chemicals. An ERMQ>0.85 or a PEL Q >1.29 was indicative of stations where multiple chemicals were significantly elevated using a 90th percentile threshold. Stations with any chemical concentration >4 times its respective ERM or >5.9 times its respective PEL were considered to exhibit elevated chemistry. Summary quotients and magnitude of sediment quality guideline exceedances were used as additional information to help prioritize stations of concern for Regional Water Quality Control Board staff.

Identification of degraded and undegraded habitat (as determined by macrobenthic community structure) was conducted using a cumulative, weight-of-evidence approach. Analyses were performed to identify relationships between community structure within and between each station or site (*e.g.*, diversity/evenness indices, analyses of habitat and species composition, construction of dissimilarity matrices for pattern testing, assessment of indicator species, and development of a benthic index, cluster analyses, and ordination analyses).

Analyses of the 75 stations sampled for benthic community structure identified 23 undegraded stations, 43 degraded and 9 transitional stations. All sampled stations with an ERMQ>0.85 were found to have degraded communities. All sampled stations with P450 Reporter Gene System responses above 60 μg/g BaPEq. also were found to have degraded benthic communities.

The statistical significance of toxicity test results was determined using two approaches: the reference envelope approach and laboratory control comparison approach used by the United States Environmental Protection Agency- Environmental Monitoring and Assessment Program and NOAA- National Status and Trends programs. The reference envelope approach indicated that toxicity for the *Rhepoxynius abronius* (amphipod) survival sediment test was significant when survival was less than 48% in samples tested. No reference envelope was calculated for the urchin fertilization or development tests due to high variability in porewater data from reference stations.

The laboratory control comparison was used for the larval development test. This approach was used to compare test sediment samples against laboratory controls for determination of statistically significant differences in test organism response. Criteria for toxicity in this approach were 1) survival less than 80% of the control value and 2) significant difference between test samples and controls, as determined using a separate variance t-test. Using this approach, there was no absolute value below which all samples could be considered toxic, although survival below a range of 72-80% generally was considered toxic.

Using the EMAP definition of toxicity, 56% of the total area sampled was toxic to *Rhepoxynius*. For the *Strongylocentrotus* larval development test, percent of total area toxic was 29%, 54%, and 72% respectively for 25%, 50%, and undiluted porewater concentrations. Samples representing 14%, 27%, or 36% of the study area were toxic to both *Strongylocentrotus* in pore water (25%, 50%, or undiluted, respectively) and *Rhepoxynius* in solid phase sediment.

Linear regression analyses failed to reveal strong correlations between amphipod survival and chemical concentration. It is suspected that instead of a linear response to chemical pollutants, most organisms are tolerant of pollutants until a threshold is exceeded. Comparisons to established sediment quality guideline thresholds demonstrate an increased incidence of toxicity for San Diego Bay Region samples with chemical concentrations exceeding the ERM or PEL values. It is further suspected that toxicity in urban bays is caused by exposure to complex mixtures of chemicals. Comparisons to chemical summary quotients (multiple chemical indicators) demonstrate that the highest incidence of toxicity (>78%) is found in samples with multiple elevated chemicals (ERMQ >0.85).

Statistical analyses of the P450 Reporter Gene System responses versus the PAHs in sediment extracts demonstrated that this biological response indicator was significantly correlated ($r^2 = 0.86$, n=30) with sediment PAH (total and high molecular weight) concentration.

Stations requiring further investigation were prioritized based on existing evidence. Each station receiving a high, moderate or low priority ranking meets one or more of the criteria under evaluation for determining hot spot status in the Bay Protection and Toxic Cleanup Program. Those meeting all criteria were given the highest priority for further action. A ranking scheme was developed to evaluate stations of lower priority.

Seven stations (representing four sites) were given a high priority ranking, 43 stations were given a moderate priority ranking, and 57 stations were given a low priority ranking. The seven stations receiving the high priority ranking were in the Seventh Street channel area, two naval shipyard areas near the Coronado Bridge, and the Downtown Anchorage area west of the airport. A majority of stations given moderate rankings were associated with commercial areas and naval shipyard areas in the vicinity of the Coronado Bridge. Low priority stations were interspersed throughout the San Diego Bay Region.

A review of historical data supports the conclusions of the current research. Recommendations were made for complementary investigations which could provide additional evidence for further characterizing stations of concern.

Unresolved issues from earlier studies

Although an attempt was made to gain complete information on the most important sites during the original study, some sites did not receive a full suite of analyses due to budgetary or programmatic constraints. After analysis of the original data set, eight sites were identified as probable areas of concern based on existing information, but appropriate prioritization could not be accomplished because of one or more types of missing data (Table 1). These sites were revisited and samples collected to obtain additional information regarding chemical, toxicological and benthic community conditions. This information was needed to better evaluate the station's priority for future investigation.

Los Penasquitos Lagoon (95006), which was visited during a study of southern California estuaries, exhibited strong toxic responses in bioassays and was determined to have a degraded benthic community (Anderson *et al*, 1997). However, no associated elevated chemical levels were indicated. The possibility existed at this site that pollutants were present that were not included in the normal suite of analyses or that toxicity was a result of non-anthropogenic effects. A toxicity identification evaluation (TIE) was proposed for the current study to

Table 1. Stations to be Revisited

Station #	Station	IDORG	Previous Results
90007.0	25 Swartz (Naval Base O10)	1673	Single toxicity, elevated chem, previous degraded benthics
90008.0	27 Swartz (Naval Base O13)	1674	Single toxicity, previously degraded benthics, low chem
90022.0	P Swartz (Naval Base O12)	1675	Single toxicity, previously degraded benthics, moderate chem
90039.0	CI	1676	Single toxicity, elevated chem, benthics not analyzed
93179.0	Naval Shipyards O3	1677	Repeated toxicity, elevated chem, Adjacent site degraded benthics
90020.0	G De Lappe	1678	Elevated chem, marginal toxicity, benthics not analyzed
93178.0	Naval Shipyards O2	1679	Elevated chem, marginal toxicity, benthics not analyzed
95006.0	Los Penasquitos (319)	1681	Repeated toxicity, low chem, degraded benthics
90013.0	37 Swartz (Marina)	1680	Reference Site

evaluate the source of this toxic response. A TIE was designed to evaluate pore water toxicity using the *Strongylocentrotus purpuratus* larval development test and the *Eohaustorius estuarius* 10 day survival test.

Figure 1 shows sample locations for the eight revisited stations in San Diego Bay and the TIE station in Los Penasquitos Lagoon.

Data reported for the P-450 Reporter Gene System responses in the appendix of the original report were mismatched against station numbers. This error is corrected in the appendix of this report and stations are correctly matched .

METHODS

Methods for sample collection and processing, trace metal analysis, trace organic analysis, total organic carbon analysis, grain size analysis and benthic community taxonomy are identical to those described in the original San Diego report (Fairey *et al.*, 1996). Methods for toxicity have been modified slightly and are described in the following section. Methods for TIE analysis also are described in the following section.

Toxicity Testing

Toxicity testing for this study utilized slightly different protocols than were used for the previous San Diego Bay study. Solid phase testing used the estuarine amphipod *Eohaustorius estuarius* due to concerns that *Rhepoxynius* might be sensitive to fine grained sediments at

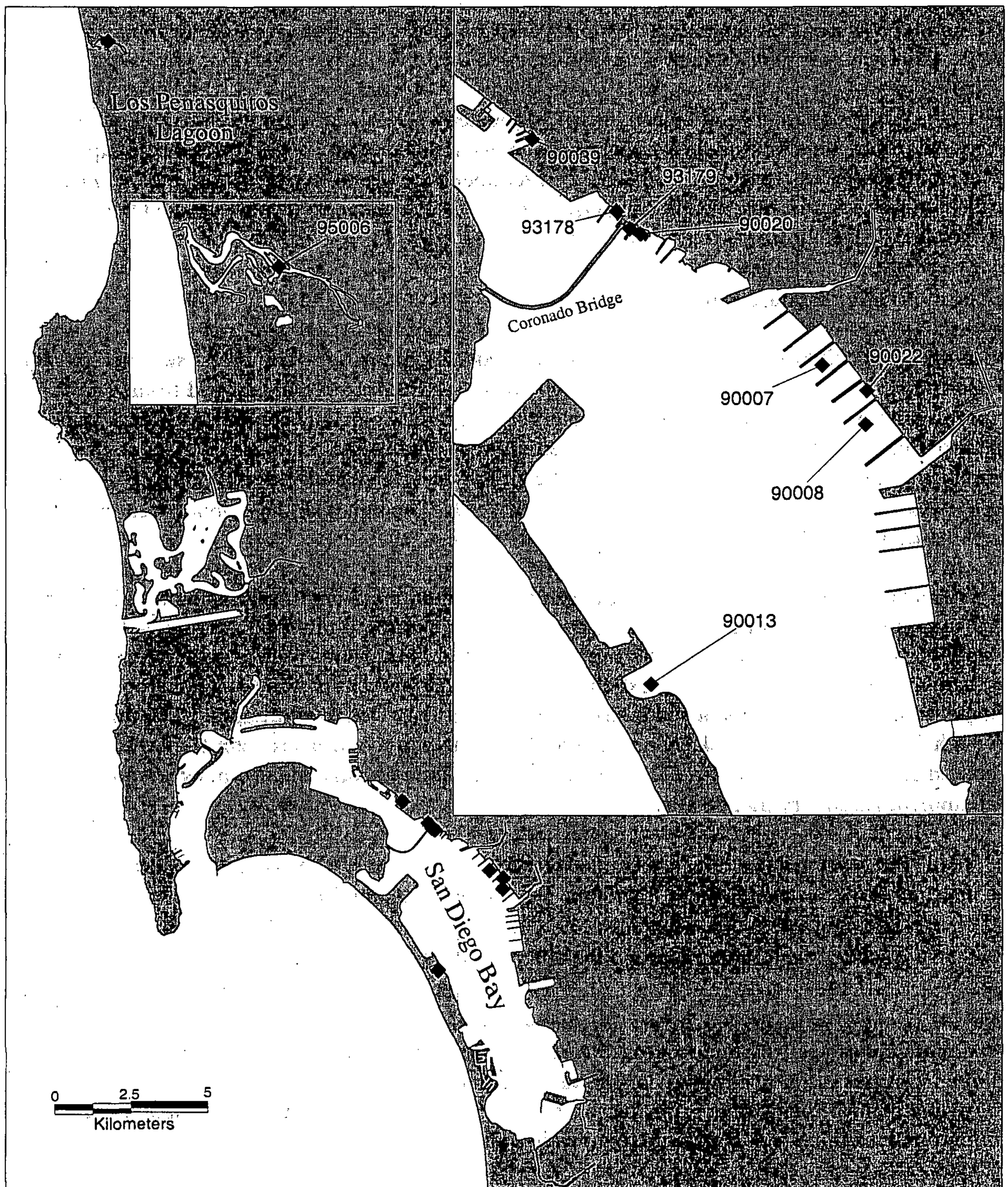


Figure 1. San Diego Bay Region Study Area and Sampling Sites.

some of the stations investigated. Test protocols for the two species are nearly identical with only salinity adjustments being of note, as described below.

The sea urchin larval development test was conducted on sediment pore water samples for the previous San Diego bay study. Recent research using this protocol has indicated that exposure of developing embryos at the interface between sediment and water provides a more ecologically relevant bioassay for this species (Anderson *et al*, 1997). The current study utilized the sediment water interface exposure, as described below.

Amphipod Solid Phase Survival Tests

Solid-phase sediment sample toxicity was assessed using the 10-day amphipod survival toxicity test protocols outlined in EPA 1994. All *Eohaustorius estuarius* were obtained from Northwestern Aquatic Sciences in Yaquina Bay, Oregon. Animals were separated into groups of approximately 100 and placed in polyethylene boxes containing Yaquina Bay collection site sediment, then shipped on ice via overnight courier. Upon arrival at Granite Canyon, the *Eohaustorius* were acclimated to 20‰ (T=15°C). Once acclimated, the animals were held for an additional 48-hours prior to addition to the test containers.

Test containers were one liter glass beakers or jars containing 2-cm of sediment and filled to the 700-ml line with control seawater adjusted to the appropriate salinity using spring water or distilled well water. Test sediments were not sieved for indigenous organisms prior to testing although at the conclusion of the test, the presence of any predators was noted and recorded on the data sheet. Test sediment and overlying water were allowed to equilibrate for 24 hours, after which 20 amphipods were placed in each beaker along with control seawater to fill test containers to the one-liter line. Test chambers were aerated gently and illuminated continuously at ambient laboratory light levels.

Five laboratory replicates of each sample were tested for ten days. A negative sediment control consisting of five lab replicates of Yaquina Bay home sediment for *Eohaustorius* was included with each sediment test. After ten days, the sediments were sieved through a 0.5-mm Nitex screen to recover the test animals, and the number of survivors was recorded for each replicate.

Positive control reference tests were conducted concurrently with each sediment test using cadmium chloride as a reference toxicant. For these tests, amphipod survival was recorded in three replicates of four cadmium concentrations after a 96-hour water-only exposure. A negative seawater control consisting of one micron-filtered Granite Canyon seawater, diluted to the appropriate salinity, was compared to all cadmium concentrations.

Amphipod survival for each replicate was calculated as:

$$\frac{\text{(Number of surviving amphipods)}}{\text{(Initial number of amphipods)}} \times 100$$

Sea Urchin Embryo-Larval Development Test using the Sediment-Water Interface Exposure System

The purple sea urchin (*Strongylocentrotus purpuratus*) embryo/larval development test at the sediment-water interface was conducted on intact core sediment samples taken with minimal disturbance from the Van Veen grab sampler. Details of the test protocol are given in the MPSL Standard Operating Procedure, which follows the EPA methods manual (1995). A brief description of the method follows.

Sea urchins were collected from the Monterey County coast near Granite Canyon, and held at MPSL at ambient seawater temperature and salinity until testing. Adult sea urchins were held in complete darkness to preserve gonadal condition. On the day of the test, urchins were induced to spawn in air by injection with 0.5 ml of 0.5M KCl. Eggs and sperm collected from the urchins were mixed in seawater at a 500 to 1 sperm to egg ratio, and embryos were distributed to the test containers within one hour of fertilization. Sediment-water interface test containers consisted of a polycarbonate tube with a 25-µm screened bottom placed so that the screen was within 1-cm of the surface of an intact sediment core (Anderson *et al.* 1996). Seawater at ambient salinity was poured into the core tube and allowed to equilibrate for 24 hours before the start of the test. After inserting the screen tube into the equilibrated cores, each tube was inoculated with approximately 250 embryos. The laboratory control consisted of Yaquina Bay amphipod home sediment from Northwestern Aquatic Sciences. Tests were conducted at ambient seawater salinity ± 2‰. Ambient salinity at Granite Canyon is usually 32 to 34‰. A positive control reference test was conducted concurrently with the test using a dilution series of copper chloride as a reference toxicant.

After an exposure period of 96 hours, larvae were fixed in 5% buffered formalin. One hundred larvae in each container were examined under an inverted light microscope at 100x to determine the proportion of normally developed larvae as described in EPA 1995. Percent normal development was calculated as:

$$\frac{\text{Number of normally developed larvae counted}}{\text{Total number of larvae counted}} \quad \text{X} \quad 100$$

Determination of Toxicity

Determination of toxicity to amphipods relied on the reference envelope approach described previously (Fairey *et al.*, 1996). In determination of toxicity for the reference envelope approach, values must be chosen for alpha and the percentile (p) to calculate the edge of the reference envelope (L) using the following equation:

$$L = X_r - [\, g_{a,p,n} * S_r \,]$$

The values of alpha and p are chosen to express the degree of certainty desired when classifying a sample as toxic. In this study values of alpha=.05 and p=1 were used to distinguish the most toxic samples which have a 95% certainty of being in the most toxic 1% . This calculation resulted in a determination of toxicity for the *Rhepoxynius* test when samples had a mean survival of less than 48%. This cutoff is as a statistical determination chosen as a conservative guideline for setting priorities for future work, by identifying only the most toxic stations. This same determination of toxicity was applied to the *Eohaustorius* test assuming exposure routes and sensitivities were similar for the two species.

Determination of toxicity to urchin larvae using the sediment water interface exposure was made by comparisons to laboratory controls. Samples were defined as significantly more toxic than laboratory controls if the following two criteria were met: 1) a separate-variance t-test determined there was a significant difference ($p<0.05$) in mean toxicity test organism response (e.g., percent survival) between the sample and the laboratory control and 2) mean organism response in the toxicity test was lower than a certain percentage of the control value, as determined using the 90th percentile Minimum Significant Difference (MSD).

Statistical significance in t-tests is determined by dividing an expression of the difference between sample and control by an expression of the variance among replicates. A "separate variance" t-test that adjusted the degrees of freedom was used to account for variance heterogeneity among samples. If the difference between sample and control is large relative to the variance among replicates, then the difference is determined to be significant. In many cases, however, low between-replicate variance will cause the comparison to be considered significant, even though the magnitude of the difference can be small. The magnitude of difference identified as significant is termed the Minimum Significant Difference (MSD) which is dependent on the selected alpha level, the level of between-replicate variation, and the number of replicates specific to the experiment. With the number of replicates and alpha level held constant, the MSD varies with the degree of between-replicate variation. The "detectable difference" inherent to the toxicity test protocol can be determined by identifying the magnitude of difference detected by the protocol 90% of the time (Schimmel *et al.*, 1991; Thursby and Schlekat, 1993). This is equivalent to setting the level of statistical power at 0.90 for these comparisons. This is accomplished by determining the MSD for each t-test conducted, ranking them in ascending order, and identifying the 90th percentile MSD, the MSD that is larger than or equal to 90% of the MSD values generated.

Current BPTCP detectable difference (90th percentile MSD) for the urchin SWI test is 59% of controls, based on an evaluation of 109 samples. Samples with toxicity test results lower than the values given, as a percentage of control response, would be considered toxic if the result also was significantly different from the control in the individual t-test.

Toxicity Identification Evaluations (TIEs)

Phase I TIEs were designed to characterize samples by isolating broad classes of compounds to determine their relationship to observed toxicity. Phase I TIE procedures include adjustment of sample pH, chelation of cationic compounds (including many trace metals), neutralization of oxidants (such as chlorine), aeration to remove volatiles, inactivation of metabolically activated toxicants, solid-phase extraction (SPE) of non-polar organic compounds on C-18 columns, and subsequent elution of extracted compounds. Each sample fraction, in which classes of compounds have been removed, inactivated, or isolated, then is tested for toxicity. TIE procedures followed the methods described by US EPA (1996).

AVS/SEM Methods

Samples were prepared for Acid Volatile Sulfide (AVS) extraction by weighing a 2 gram sediment sample into a pre-weighed Teflon® bomb. Samples were diluted with 100 ml of oxygen-free MilliQ® water and bubbled with nitrogen gas for 10 minutes. AVS in the sample was converted to hydrogen sulfide gas (H_2S) by acidification with 20 ml of 6 M hydrochloric acid at room temperature. The H_2S was then purged from the sample with nitrogen gas and trapped in 80 ml of 0.5 M sodium hydroxide. The amount of sulfide that has been trapped is then determined by colorimetric methods. The Simultaneously Extracted Metals (SEM) are selected metals liberated from the sediment during the acidification procedure. SEM analysis is conducted with 20 ml of centrifuged sample supernatant taken after AVS extraction. The H_2S released by acidifying the sample is quantified using a colorimetric method:

Hydrogen sulfide is trapped in 80 ml of 0.5M NaOH. Ten ml of this solution is added to a 100 ml volumetric flask containing 70 ml of sulfide-free 0.5M NaOH, 10 ml of MDR reagent and 10 ml of DI water. The sulfide reacts with the N-N-dimethyl-p-phenylenediamine in the MDR reagent to form methylene blue. Absorbances are determined with a Milton Roy Spectronic 301 Spectrophotometer and compared to a standardized curve.

Table 2. AVS/SEM Analytes and Detection Limits

Analytes	*μmol/g*	*μg/g*
Cadmium	0.0001	0.01
Copper	0.02	1.0
Lead	0.001	0.1
Nickel	0.002	0.1
Zinc	0.001	0.05
Sulfide	0.5	n/a

RESULTS AND DISCUSSION

Tabulated data for all chemical, toxicological and benthic community analyses are detailed in the Appendices. The following section presents summarized data that highlights significant findings from analysis of the full data set.

Revised P450 Data

Appendix E in the original report incorrectly reported data for total PAHs when compared to P450 response at all stations sampled. It should be noted that the correct values were used for all data analyses so data interpretations were not affected by this error. Appendix G in the current report presents revised data to correct the earlier appendix error.

Chemistry

Individual chemical concentrations were compared to ERM and PEL sediment quality guidelines. These guidelines are used to indicate samples with a high probability of demonstrating biological effects (Lon and Morgan, 1990; MacDonald, 1994; Long *et al.*, 1995; Long and MacDonald, in press). Chemical analysis was not performed on the sample from Los Penasquitos Lagoon in this study, so no comparisons to guidelines were made. Sediment quality guidelines were exceeded at all San Diego Bay stations and the number of guideline exceedances was high at most stations (Table 3). Chlordane, PAHs and PCBs were the pollutants most often found at elevated concentrations at these stations. Copper, lead, mercury and zinc were often found at elevated levels in the Naval Shipyard areas, although SEM/AVS ratios indicate the probability of metal toxicity is low. This is consistent with previous results demonstrating elevated chemical concentrations at several of these stations. Findings in this study also support the selection of the reference station (90013) as representative of current background chemical conditions in San Diego Bay.

Chemical summary quotients were utilized by the San Diego Bay study to evaluate multiple chemical pollutants in samples within the San Diego Bay region. Eight sediment samples received extensive chemical analyses during the current study, allowing for calculation of summary quotients (Table 3). This approach has been used previously in the BPTCP to identify elevated chemical levels in the San Diego Bay region (Fairey *et al.*, 1996), based on evaluation of 220 sediment samples. Upper 90th percentile summary quotients for that data set were ERMQ>0.85 and PELQ>1.29, respectively. Although these values cannot be considered threshold levels with proven ecological significance, they can be used for comparative purposes to indicate the worst 10 % of the samples in the region, with respect to pollutant concentrations. These 90th percentile values were used in the current study to help identify areas of concern for the region based on comparisons to the earlier larger data set. Five of eight samples in the current study exceeded these ERMQ and PELQ percentiles demonstrating elevated multiple pollutants at these stations.

Table 3. Chemical Summary Quotient Values and Sediment Quality Guideline Exceedances

Station #	Station	IDORG	ERMQ	PELQ	> ERMs	>PELs
90007.0	25 Swartz (Naval Base O10)	1673	0.646	0.944	3	15
90008.0	27 Swartz (Naval Base O13)	1674	0.532	0.835	1	13
90022.0	P Swartz (Naval Base O12)	1675	0.958	1.398	13	19
90039.0	Cl	1676	2.180	3.785	7	20
93179.0	Naval Shipyards O3	1677	2.483	2.227	16	20
90020.0	G De Lappe	1678	2.028	2.463	12	17
93178.0	Naval Shipyards O2	1679	1.526	1.875	8	16
90013.0	37 Swartz (Marina)	1680	0.280	0.407	0	2
95006.0	Los Penasquitos (319)	1681	n/a	n/a	n/a	n/a

Use of chemical summary quotients also allows comparisons to be made between regions within the state and demonstrate that the San Diego Bay region has relatively greater pollutant levels compared to more pristine settings in northern and central California. The greatest quotient values for the north coast of California (ERMQ=0.243; PELQ=0.528) (Jacobi *et al.*, in prep) and for the central coast of California (ERMQ=0.447; PELQ=0.735)(Downing *et al.*, in prep) are considerably lower than those in the upper 10% from San Diego Bay. This is to be expected because the north coast and central coast are not as heavily populated or industrialized as the urban areas of southern California. This comparison is useful though by giving insight to the range of pollution that is represented in the state and that samples from San Diego Bay often fall within the upper end (most polluted) of the range.

Long and MacDonald (in press) further examined the use of sediment quality guidelines and the probability of toxicity being associated with summary quotient ranges. This extensive national study developed four sediment categories to help prioritize areas of concern, based on the probability of toxicity associated with summary quotients and number of individual ERM/PEL guideline exceedances. Sediments with ERM quotients > 0.51 or PEL quotients >1.5, or more than 5 guideline exceedances, were generally assigned to categories of elevated concern (medium high to high priority) because the probability of associated toxicity was greater than 50%. Five sediment samples from the current San Diego Bay study exceed these thresholds. Three of these five sediment samples demonstrated ERM quotients > 1.5 or PEL quotients >2.3 and fall within the survey's highest category. Nationwide, samples in this range were assigned the highest priority as sites of concern, based on a probability of toxicity to amphipods of >74%, and should further highlight the concern for these stations within the region. It should be noted that current BPTCP calculation methods of summary quotients vary slightly from the national study based on incorporation of a modified suite of chemicals. These modifications were incorporated because the predictability of toxicity is enhanced thus providing stronger evidence of the value of this multiple chemical indicator of biological effects.

Toxicity

Station CL (90039) exhibited toxicity to the amphipod *Eohaustorius*, based on comparison to the reference envelope (<48% survival) (Figure 2; Table 4). Samples from the remaining stations were not toxic to amphipods. Unionized ammonia concentrations in these bioassays were all below the application limit (0.8 mg/L; EPA, 1995) and likely did not contribute to observed toxicity. Hydrogen sulfide (H_2S) concentrations were well above the observed "low effects" level (0.114 mg/L; Knezovich, 1996) for three samples, including station CL (90039). H_2S might have contributed to toxicity at this station, but this seems unlikely because the H_2S concentration in the sample from station Naval Shipyard O2 (93178) was over twice as high without demonstrating toxicity.

Determination of toxicity to urchin development is based on t-test and comparison to the MSD as described earlier. Three stations exhibited toxicity to urchins in the SWI exposure (Figure 2; Table 4). Ammonia levels in these bioassays were all below the "no effects" level (0.07 mg/L; Bay, 1993) and likely did not contribute to observed toxicity. H_2S concentrations were above the observed "low effects" level (0.0076 mg/L; Knezovich, 1996) for four samples, three of which exhibited a toxic response. H_2S might have contributed to toxicity at both of these stations, but this seems unlikely at the Naval Shipyard (93178) or P Swartz (90022) stations because greater sulfide levels were measured in the 25 Swartz (90007) sample with no

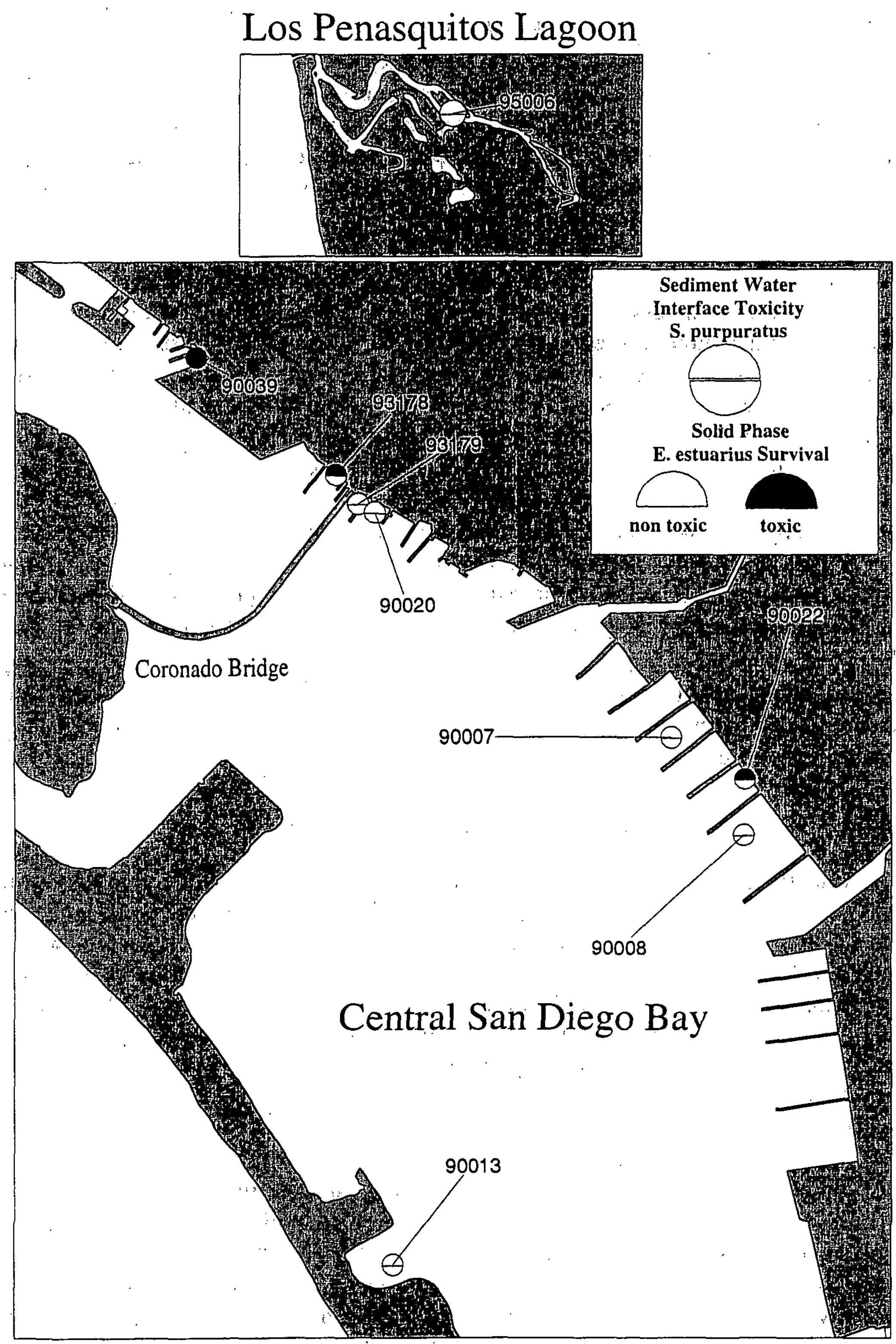


Figure 2. San Diego Bay Region Toxicity. Samples were toxic if significantly different from controls using a t-test and less than control based MSD values (see text for complete toxicity definition).

concurrent toxic effect. The concentration of H_2S in the other toxic sample (CL, 90039) should be considered as a potential confounding factor.

Only one station (CL, 90039) demonstrated concurrent toxicity to both amphipods and urchins .

Toxicity was not exhibited in the pore water sample from Los Penasquitos Lagoon. This was contrary to expectations based on two previous visits to this site. Because the initial test was not toxic, TIE analysis was not carried out using *Strongylocentrotus purpuratus*, but was initiated using *Eohaustorius estuarius* as a precautionary measure. No toxic effect was measured at any level for this test so the TIE investigation was abandoned.

Table 4. Toxicity Test Results for Amphipods (EE) and Urchins (SPDI)

Station #	Station	IDORG	EE	NH_3	H_2S	SPDI	NH_3	H_2S
90007.0	25 Swartz (Naval Base O10)	1673	87	<MDL	0.008	76	0.008	**0.050**
90008.0	27 Swartz (Naval Base O13)	1674	91	0.008	<MDL	94	0.003	0.006
90022.0	P Swartz (Naval Base O12)	1675	83	0.003	0.007	**43**	0.004	**0.008**
90039.0	CL	1676	**22**	0.056	**0.269**	**38**	0.001	**0.277**
93179.0	Naval Shipyards O3	1677	87	0.007	0.007	74	<MDL	0.002
90020.0	G De Lappe	1678	66	0.064	0.050	57	0.003	0.001
93178.0	Naval Shipyards O2	1679	88	0.042	**0.646**	**2**	0.010	**0.016**
90013.0	37 Swartz (Marina)	1680	83	0.020	**0.173**	78	0.010	0.007
95006.0	Los Penasquitos (319)	1681	84	0.069	0.071	67	0.004	0.005

Bolded values indicate samples that were toxic or exceeded water quality effects thresholds

Benthic Community Degradation

Results of all benthic community analyses conducted as part of this study are presented in tables in Appendix F. These tables show the species, taxa, number of individuals per core, and summary statistics for the 8 stations sampled.

The current study utilizes a Relative Benthic Index (RBI) based on modification of indices used in San Diego (Fairey *et al.,* 1996) and in southern California (Anderson *et al.,* 1997). The San Diego study had 75 samples for which the indices were derived and used a number of techniques to generate categorical community classifications as degraded, transitional or undegraded. The southern California study contained 43 samples and was a modified version of the earlier San Diego evaluation. The modification was primarily based on quantifying community classifications on a graduated scale from 0 to 1. The Relative Benthic Index used in this study incorporates refinements from both previous studies and quantifies community health on a graduated scale of 0 to 1. It combines use of benthic community data with the presence or absence of positive and negative indicator species in order to provide a measure of the relative degree of degradation within the benthic fauna. The index does not require the presence of an uncontaminated reference station and relies on the larger data set from the 1996 San Diego study to establish high and low ranges for the region. Because of small sample size (n=8) the current index is not based on samples collected exclusively during the current study. The RBI however does provide the relative "health" of each of the stations in the current data set compared to stations from the previous data set.

The Relative Benthic Index for the current 8 samples region ranged between 0.02 and 1.0 (Table 5). Stations with greater numbers of negative indicator species, such as polychaetes and oligochaetes, in association with low species diversity generally denote an area of disturbance and score lower with the index. In contrast, stations with a greater number of positive indicator species, such a gammarid amphipods or ostracods, and higher species diversity indicate a relatively undisturbed area with a mature benthic community and score higher with the index. Selection of indicator species is based on the best professional judgement of benthic ecologist familiar with species in the region. Four stations with a RBI ≤ 0.3 were classified as having degraded benthic communities (Figure 3). Three stations were classified as having transitional benthic communities (characteristics of both healthy and impacted communities; 0.3≤ RBI ≤ 0.6) and one station was classified as undegraded (RBI>0.6). The undegraded station was selected for this study as a reference site due to previously determined low chemical concentrations and undegraded benthic community. Findings in the current study support the selection of this station as representative of reference conditions.

Table 5. Relative Benthic Index (RBI) Values

Station #	Station	IDORG	RBI
90007.0	25 SWARTZ (NAVAL BASE O10)	1673	0.16
90008.0	27 SWARTZ (NAVAL BASE O13)	1674	0.24
90022.0	P SWARTZ (NAVAL BASE O12)	1675	0.38
90039.0	CL	1676	0.02
93179.0	NAVAL SHIPYARDS O3	1677	0.42
90020.0	G DE LAPPE	1678	0.29
93178.0	NAVAL SHIPYARDS O2	1679	0.41
90013.0	37 SWARTZ (MARINA)	1680	1.00
95006.0	LOS PENASQUITOS (319)	1681	n/a

Station Specific Sediment Quality Assessments

Sediment samples from each of the stations in San Diego Harbor were analyzed for chemical concentration, toxicity and benthic community structure. This synoptic study design allows for the assessment of sediment quality using a complementary weight of evidence from observed biological effects and potential pollutants. Prioritizations were made to help focus RWQCB and SWRCB staff on sediments that pose a threat to the water body. Assessments followed those of the previous San Diego Region report by relying on the combination and severity of environmental measures to categorize stations as a high, moderate, or low priority. Sediments that exhibited strong toxic responses, and/or degraded resident communities, and were associated with identifiable pollutants, were given the highest priority for further investigation. Sediments with reduced or negligible responses were given lower priorities for investigation or recommended for no further action. Limited personnel and resources can therefore be focused on sediments that most likely pose a threat to the environment in San Diego Bay.

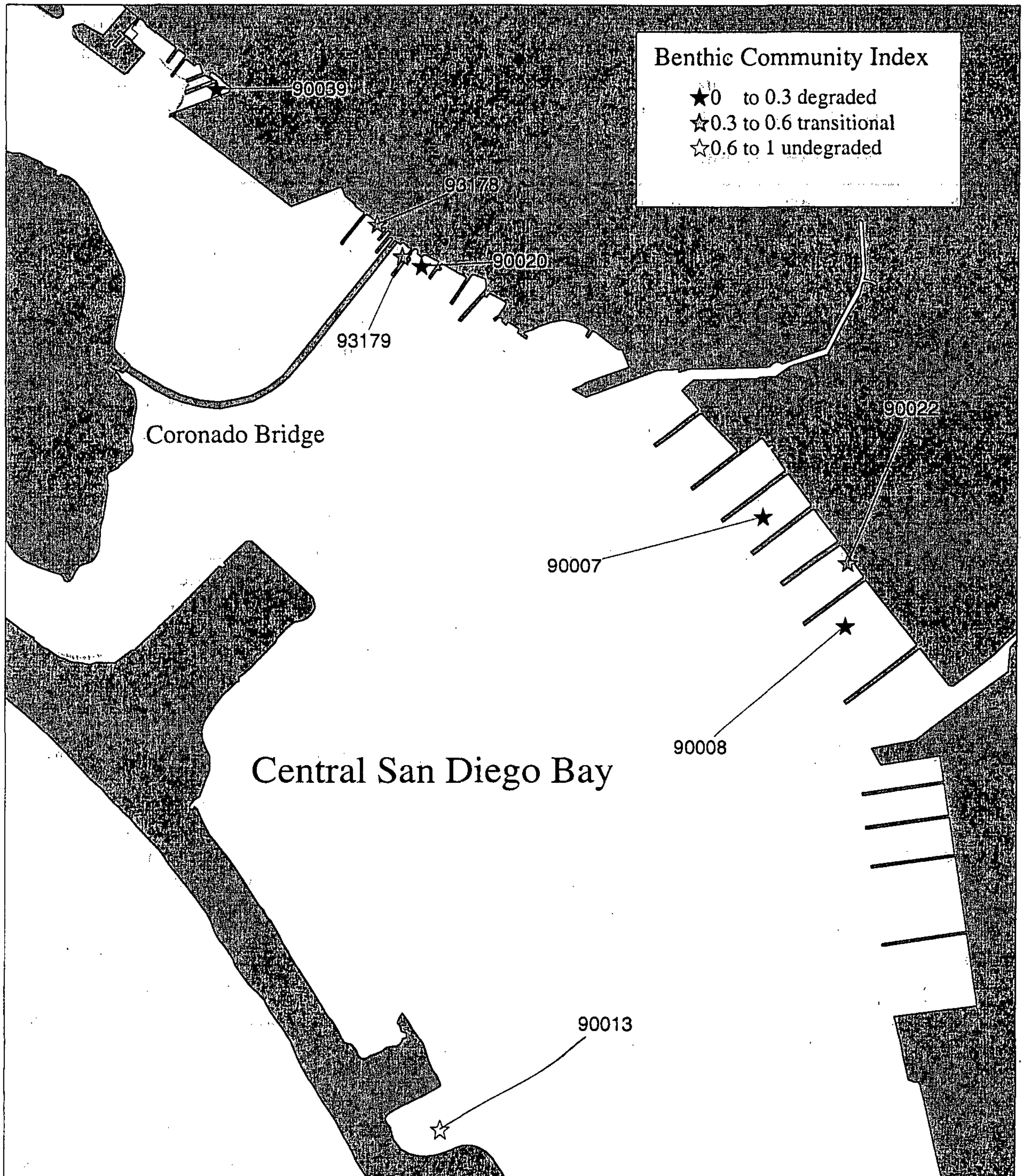


Figure 3. San Diego Bay Region Benthic Community Indices.

Table 6 summarizes chemical concentrations, toxicity and benthic community structure for the eight stations sampled in San Diego Bay. Comments summarize the weight of evidence at each station and a priority is assigned for future investigation. The locations and priority categories for each station are shown in Figure 4.

Table 6. Station Prioritization

Station #	Station	IDORG	ERMQ	PELQ	EE	SPDI	RBI	Comments	Priority
90039.0	CL	1676	**2.14**	**3.79**	**22**	**38**	**0.02**	Elevated Chem. Toxicity Degraded Comm.	High
93178.0	Naval Shipyards O2	1679	**1.37**	**1.88**	88	**2**	0.41	Elevated Chem. Toxicity Transitional Comm.	Moderate
90022.0	P Swartz (Naval O12)	1675	**0.86**	**1.40**	83	**43**	0.38	Elevated Chem. Toxicity Transitional Comm.	Moderate
90020.0	G De Lappe	1678	**1.84**	**2.46**	66	57	**0.29**	Elevated Chem. No Toxicity Degraded Comm.	Moderate
93179.0	Naval Shipyards O3	1677	**1.55**	**2.23**	87	74	0.42	Elevated Chem. No Toxicity Transitional Comm.	Moderate
90007.0	25 Swartz (Naval O10)	1673	0.59	0.94	87	76	**0.16**	Chem. Not Elevated No Toxicity Degraded Comm.	Low
90008.0	27 Swartz (Naval O13)	1674	0.49	0.84	91	94	**0.24**	Chem. Not Elevated No Toxicity Degraded Comm.	Low
90013.0	37 Swartz (Marina)	1680	0.23	0.40	83	78	1.00	Chem. Not Elevated No Toxicity Undegraded Comm.	No action

Bolded values indicate samples that were toxic or exceeded BPTCP thresholds

Station CL (90039) was assigned the highest priority. This station was given a moderate priority in the previous report because benthic community analysis had not been performed and only one toxic response had been observed. The sample collected at this station during the current study again exhibited toxicity to amphipods and urchin larvae, elevated chemicals, particularly pesticides and PAHs, and a degraded resident benthic community. The station is located at the mouth of Switzer Creek where a concrete culvert empties into the bay.

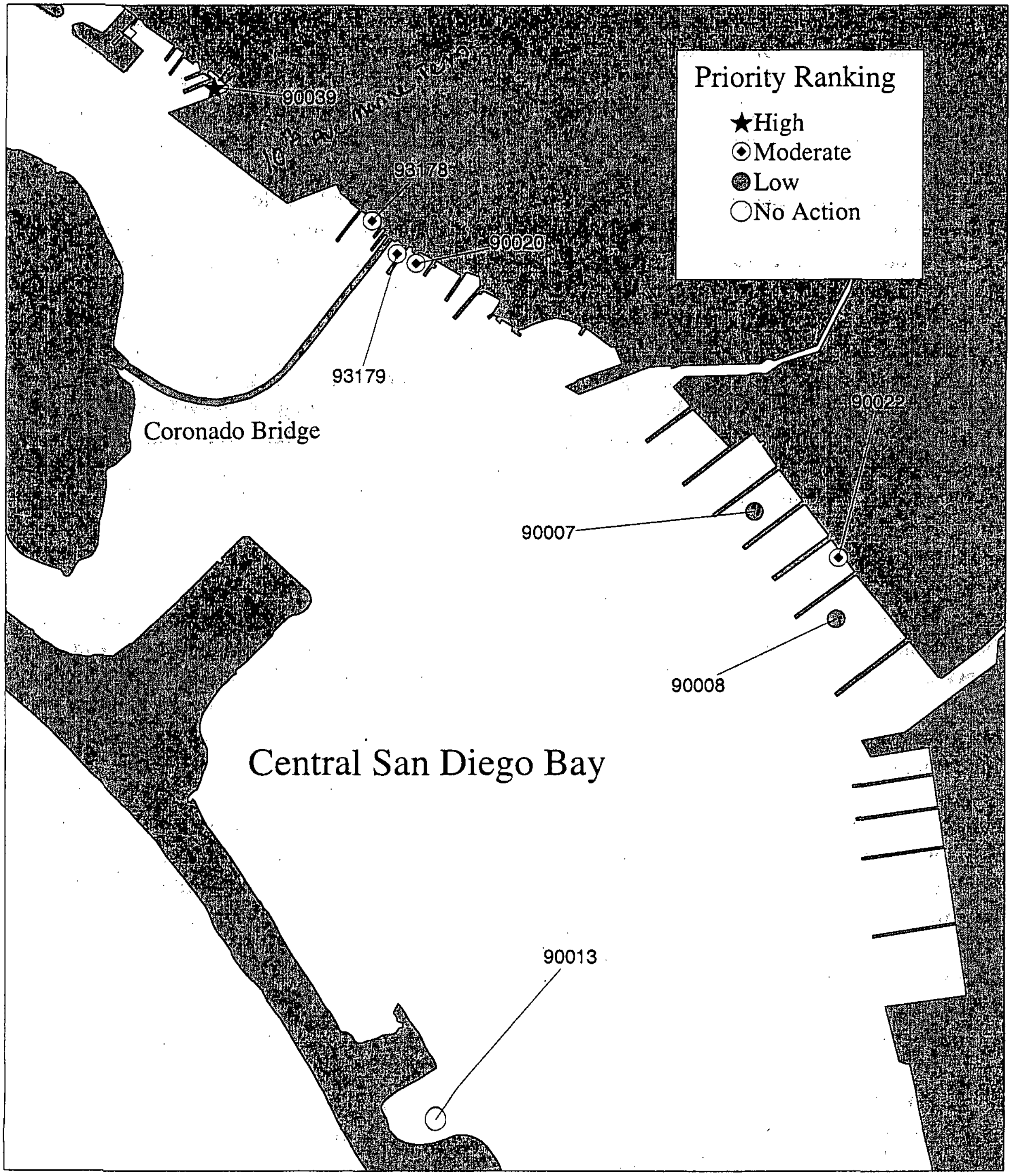


Figure 4. San Diego Bay Region Priority Ranking.

Historically this area served as a PAH waste dump site for a San Diego Gas and Electric coal gasification plant. Prior to that the site served as one of the original garbage dumps in the San Diego region (Port of San Diego, 1996). Pesticide residues and organic matter were prevalent in the sediment samples and indicate a probable link to urban and storm runoff. Moving this station to higher priority is strongly supported by evidence gathered in the current and previous study.

Three stations were assigned to a moderate priority category based on elevated chemical levels and one measure of biological effect. Each of these stations is in an area of current or past ship repair operations. The Naval Shipyard O2 station (93178), just north of the Coronado Bridge and near Continental Maritime, represents an area which has served as a ship repair facility for the past ten years and prior to that was the location of a tuna cannery. PCBs are the principal pollutant at this site. The P Swartz (90022) station is in the Naval Shipyard between Piers 5 and Pier 6, near the mouth of the Graving Dock. Ship repair activities are a likely source of PAHs, PCBs and copper which were the prominent pollutants at the site. Station G De Lappe (90020) is located just south of the Coronado Bridge, near Southwest Marine, where industrial and shipping activities have been in operation for many years. Sources of elevated PCBs and PAHs in samples may be from commercial activities or from fill material that was added along the shoreline in the past. Each of these stations received a moderate priority in the previous study and the current study supports this prioritization.

One station was assigned to a moderate priority category based on an inconclusive measure of biological effects. The Naval Shipyards O3 station (93179) was assigned a high priority in the previous study based on elevated chemistry, presence of toxicity, and degradation of the benthic community at an adjacent station. In the current study lack of toxicity, continued elevated chemistry and a transitional benthic community prompted re-assignment of this station to the moderate category.

Stations 25 Swartz (90007) and 27 Swartz (90008) were assigned moderate priorities in the previous study based on moderate chemical levels, a single toxic response and a degraded benthic community at an adjacent station. Data from the current study indicated low to moderate chemical levels, however toxicity was absent. The benthic communities were classified as degraded, but unclear association of elevated chemicals prompted re-classification of these two stations to a lower priority.

CONCLUSIONS

The current study was designed to better evaluate sediment quality at eight stations within San Diego Harbor where missing or inconclusive data from a previous study confounded interpretations. Collection of synoptic chemical, toxicological and benthic community data provided the needed information to prioritize these stations, utilizing a strong weight of evidence approach. This approach helped identify stations with sediments that have a high probability of causing adverse environmental impacts. A significant limitation of this study is the inability to directly link cause and effect or to delineate the boundaries of the impacted area. Subsequent studies will be required to address these critical issues. The current study does, however, help focus future management efforts on the stations of greatest concern.

The investigation of toxicity at Los Penasquitos Lagoon was terminated when initial tests revealed that samples were not toxic. Low levels of measured chemicals in the previous study and the transitory nature of toxicity at this location make it difficult to attribute a cause to the observed effects. No further action is recommended for this location.

REFERENCES

Anderson, B., J. Hunt, S. Tudor, J. Newman, R. Tjeerdema, R Fairey, J. Oakden, C. Bretz, C. Wilson, F. La Caro, G. Kapahi, M.Stephenson, M. Puckett, J. Anderson, E. Long, and T. Flemming. 1997. Chemistry, toxicity and benthic community conditions in sediments of selected southern California bays and estuaries. Final Report. California State Water Resources Control Board. Sacramento, CA.

Anderson, B., J. Hunt, M. Hester, and B. Phillips. 1996. Assessment of sediment toxicity at the sediment-water interface. *In* Techniques in Aquatic Toxicology, G.K. Ostrander (ed). Lewis Publishers: Ann Arbor, MI.

Bay, S., R. Burgess, and D. Greenstein. 1993. Status and applications in the Echinoid (Phylum Echinodermata) toxicity test methods. In: W.G. Landis, J.S. Hughes and M.A. Lewis, eds. Environmental Toxicology and Risk Assessment. ASTM, STP 1179, Philadelphia, PA.

Downing, J., R. Fairey, C. Roberts, E. Landrau, R. Clark, J. Hunt, B. Anderson, B. Phillips, C. Wilson, F. La Caro, G. Kapahi, K. Worcester, M. Stephenson, and M. Puckett. 1998 (in prep.). Chemical and biological measures of sediment quality in the Central Coast Region. Draft Report. California State Water Resources Control Board. Sacramento, CA.

Fairey, R., C. Bretz, S. Lamerdin, J. Hunt, B. Anderson, S. Tudor, C. Wilson, F. La Caro, M. Stephenson, M. Puckett, and E. Long. 1996. Chemistry, toxicity, and benthic community conditions in sediments of the San Diego Bay Region. Final Report. California State Water Resources Control Board. Sacramento, CA.

Jacobi, M., R. Fairey, C. Roberts, E. Landrau, J. Hunt, B. Anderson, B. Phillips, C. Wilson, F. La Caro, B. Gwynne, M. Stephenson, and M. Puckett. 1998 (in prep.). Chemical and biological measures of sediment quality and tissue bioaccumulation in the North Coast Region. Draft Report. CA State Water Resources Control Board. Draft Report. Sacramento, CA

Knezovich, J., D. Steichen, J. Jelinski, and S. Anderson. 1996. Sulfide tolerance of four marine species used to evaluate sediment and pore water toxicity. Bull. Environ. Contam. Toxicol. 57:450-457.

Long, E. and D. MacDonald. *In Press*. Recommended uses of empirically-derived, sediment quality guidelines for marine and estuarine ecosystems. Human and Ecological Risk Assessment.

Long, E., J. Field, D. MacDonald. 1998. Predicting toxicity in marine sediments with numerical sediment quality guidelines. Environmental Toxicology and Chemistry 17(4):714-727.

Long, E., D. MacDonald, S. Smith and F. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental Management 19(1): 81-97.

Long, E. and L. Morgan. 1990. The potential for biological effects of sediment-sorbed contaminants tested in the national Status and Trends Program. NOAA Technical Memorandum NOS OMA 62. National Oceanic and Atmospheric Administration, Seattle, WA. 86 pp.

MacDonald, D. 1994. Approach to the assessment of sediment quality guidelines in Florida coastal waters. Volume 1- Development and evaluation of sediment assessment guidelines. Prepared for the Florida Department of Environmental Regulation. MacDonald Environmental Services, Ltd. Ladysmith, British Columbia. 52 pp.

Port of San Diego. 1996. A Historical Perspective of the Eigth Avenue Tidelands Dump. Environmental Management Department of the San Diego Unified Port District. San Diego, CA.

Thursby, G. and C. Schlekat. 1993. Statistical analysis of 10-day solid phase toxicity data for amphipods. Abstract, 14th Annual Meeting, Society of Environmental Toxicology and Chemistry.

Schimmel, S., B. Melzian, D. Campbell, C. Strobel, S. Benyi, J. Rosen, H. Buffum, and N. Rubenstein. 1991. Statistical summary: EMAP-Estuaries, Virginian Province. EPA/620/R-94/005.

U.S. Environmental Protection Agency. 1996. Marine Toxicity Identification Evaluations (TIE): Phase I Guidance Document. EPA/600/R-96/054. September, 1996. Office of Research and Development. Washington, D.C. U.S.A.

U.S. Environmental Protection Agency. 1995. Short term methods for estimating the chronic toxicity of effluent and receiving waters to west coast marine and estuarine organisms. EPA/600/R-95/136. Office of Research and Development. Washington, D.C., U.S.A.

U.S. Environmental Protection Agency. 1994. EPA. 1994. Methods for assessing the toxicity of sediment-associated contaminants with estuarine and marine amphipods. EPA 600/R-94/025. Office of Research and Development. Washington, D.C. U.S.A.

CHEMISTRY, TOXICITY AND BENTHIC COMMUNITY CONDITIONS IN SEDIMENTS OF THE SAN DIEGO BAY REGION

FINAL ADDENDUM REPORT

September 30, 1998

ID org = unique sample number

California State Water Resources Control Board

San Diego Regional Water Quality Control Board

California Department of Fish and Game
Marine Pollution Studies Laboratory

Moss Landing Marine Laboratories

University of California, Santa Cruz

AUTHORS

Russell Fairey, James Downing, Cassandra Roberts and Eli Landrau
San Jose State University- Moss Landing Marine Laboratories

John Hunt and Brian Anderson
University of California Santa Cruz

Craig J. Wilson, Gita Kapahi and Fred LaCaro
State Water Resources Control Board

Pete Michael
California Regional Water Quality Control Board- San Diego Region

Mark Stephenson and Max Puckett
California Department of Fish and Game

ACKNOWLEDGMENTS

This study was completed thanks to the efforts of the following institutions and individuals:

State Water Resources Control Board- Division of Water Quality
Bay Protection and Toxic Cleanup Program

Craig Wilson, Mike Reid, Fred LaCaro
Syed Ali, Gita Kapahi

Regional Water Quality Control Board- Region 9

Pete Michael

California Department of Fish and Game
Environmental Services Division

Mark Stephenson, Max Puckett, Gary Ichikawa
Kim Paulson, Jon Goetzl, Mark Pranger

San Jose State University- Moss Landing Marine Laboratories

Sample Collection and Data Analysis

Russell Fairey, Cassandra Roberts, James Downing
Ross Clark, Michele Jacobi, Stewart Lamerdin
Eli Landrau

Total Organic Carbon and Grain Size Analyses

Pat Iampietro, Bill Chevalier, Craig Hunter

Dissolved Organic Carbon Analysis
Steve Fitzwater

Benthic Community Analysis

John Oliver, Jim Oakden, Carrie Bretz
Peter Slattery

ACKNOWLEDGMENTS (continued)

University of California at Santa Cruz

Dept. of Chemistry and Biochemistry- Trace Organic Analyses

Ronald Tjeerdema	John Newman	Debora Holstad
Katharine Semsar	Thomas Shyka	Gloria J. Blondina
Linda Hannigan	Laura Zirelli	James Derbin
Matthew Stoetling	Raina Scott	Dana Longo
Elise Gladish-Wilson	Jon Becker	

Institute of Marine Sciences- Toxicity Testing

John Hunt	Brian Anderson	Bryn Phillips
Witold Piekarski	Michelle White	Patty Nicely
Shirley Tudor	Matt Englund	

Funding was provided by:

State Water Resources Control Board- Division of Water Quality
Bay Protection and Toxic Cleanup Program

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

This addendum augments the report "Chemistry, Toxicity, and Benthic Community Conditions in Sediments of the San Diego Bay Region" submitted in September 1996 (Fairey *et al.*, 1996). This and the original study were conducted as part of the Bay Protection and Toxic Cleanup Program, a legislatively mandated program designed to assess the degree of chemical pollution and associated biological effects in California's bays, estuaries, and harbors.

The original study objectives were:

1. Determine presence or absence of adverse biological effects in representative areas of the San Diego Bay Region;

2. Determine relative degree or severity of adverse effects, and distinguish more severely impacted sediments from less severely impacted sediments;

3. Determine relative spatial extent of toxicant-associated effects in the San Diego Bay Region;

4. Determine relationships between toxicants and measures of effects in the San Diego Bay Region.

The research involved chemical analysis of sediments, benthic community analysis and toxicity testing of sediments and pore water. Chemical analyses and bioassays were performed using aliquots of homogenized sediment samples collected synoptically at each station. Analysis of the benthic community structure was made on a subset of the total number of stations sampled.

Summary of findings from original report

Three hundred fifty stations were sampled between October, 1992 and May, 1994. Areas sampled included San Diego Bay, Mission Bay, the San Diego River Estuary and the Tijuana River Estuary and collectively are termed "the San Diego Bay Region". Two types of sampling designs were utilized: directed point sampling and stratified random sampling.

Chemical pollution was compared to established sediment quality guidelines. Two sets of guidelines were used: the Effects Range-Low (ERL)/Effects Range-Median (ERM) guidelines developed by NOAA (Long and Morgan, 1990; Long *et al.*, 1995) and the Threshold Effects Level (TEL)/Probable Effects Level (PEL) guidelines used by the state of Florida (MacDonald, 1994). Copper, mercury, zinc, total chlordane, total PCBs and the PAHs most often were found to exceed critical ERM or PEL values and were considered the major chemicals or chemical groups of concern in the San Diego Bay Region. Chemical summary quotients were used to develop chemical indices for addressing the pollution of sediments with multiple chemicals. An ERMQ>0.85 or a PEL Q >1.29 was indicative of stations where multiple chemicals were significantly elevated using a 90^{th} percentile threshold. Stations with any chemical concentration >4 times its respective ERM or >5.9 times its respective PEL were considered to exhibit elevated chemistry. Summary quotients and magnitude of sediment quality guideline exceedances were used as additional information to help prioritize stations of concern for Regional Water Quality Control Board staff.

Identification of degraded and undegraded habitat (as determined by macrobenthic community structure) was conducted using a cumulative, weight-of-evidence approach. Analyses were performed to identify relationships between community structure within and between each station or site (*e.g.*, diversity/evenness indices, analyses of habitat and species composition, construction of dissimilarity matrices for pattern testing, assessment of indicator species, and development of a benthic index, cluster analyses, and ordination analyses).

Analyses of the 75 stations sampled for benthic community structure identified 23 undegraded stations, 43 degraded and 9 transitional stations. All sampled stations with an ERMQ>0.85 were found to have degraded communities. All sampled stations with P450 Reporter Gene System responses above 60 µg/g BaPEq. also were found to have degraded benthic communities.

The statistical significance of toxicity test results was determined using two approaches: the reference envelope approach and laboratory control comparison approach used by the United States Environmental Protection Agency- Environmental Monitoring and Assessment Program and NOAA- National Status and Trends programs. The reference envelope approach indicated that toxicity for the *Rhepoxynius abronius* (amphipod) survival sediment test was significant when survival was less than 48% in samples tested. No reference envelope was calculated for the urchin fertilization or development tests due to high variability in porewater data from reference stations.

The laboratory control comparison was used for the larval development test. This approach was used to compare test sediment samples against laboratory controls for determination of statistically significant differences in test organism response. Criteria for toxicity in this approach were 1) survival less than 80% of the control value and 2) significant difference between test samples and controls, as determined using a separate variance t-test. Using this approach, there was no absolute value below which all samples could be considered toxic, although survival below a range of 72-80% generally was considered toxic.

Using the EMAP definition of toxicity, 56% of the total area sampled was toxic to *Rhepoxynius*. For the *Strongylocentrotus* larval development test, percent of total area toxic was 29%, 54%, and 72% respectively for 25%, 50%, and undiluted porewater concentrations. Samples representing 14%, 27%, or 36% of the study area were toxic to both *Strongylocentrotus* in pore water (25%, 50%, or undiluted, respectively) and *Rhepoxynius* in solid phase sediment.

Linear regression analyses failed to reveal strong correlations between amphipod survival and chemical concentration. It is suspected that instead of a linear response to chemical pollutants, most organisms are tolerant of pollutants until a threshold is exceeded. Comparisons to established sediment quality guideline thresholds demonstrate an increased incidence of toxicity for San Diego Bay Region samples with chemical concentrations exceeding the ERM or PEL values. It is further suspected that toxicity in urban bays is caused by exposure to complex mixtures of chemicals. Comparisons to chemical summary quotients (multiple chemical indicators) demonstrate that the highest incidence of toxicity (>78%) is found in samples with multiple elevated chemicals (ERMQ >0.85).

Statistical analyses of the P450 Reporter Gene System responses versus the PAHs in sediment extracts demonstrated that this biological response indicator was significantly correlated ($r^2 = 0.86$, n=30) with sediment PAH (total and high molecular weight) concentration.

Stations requiring further investigation were prioritized based on existing evidence. Each station receiving a high, moderate or low priority ranking meets one or more of the criteria under evaluation for determining hot spot status in the Bay Protection and Toxic Cleanup Program. Those meeting all criteria were given the highest priority for further action. A ranking scheme was developed to evaluate stations of lower priority.

Seven stations (representing four sites) were given a high priority ranking, 43 stations were given a moderate priority ranking, and 57 stations were given a low priority ranking. The seven stations receiving the high priority ranking were in the Seventh Street channel area, two naval shipyard areas near the Coronado Bridge, and the Downtown Anchorage area west of the airport. A majority of stations given moderate rankings were associated with commercial areas and naval shipyard areas in the vicinity of the Coronado Bridge. Low priority stations were interspersed throughout the San Diego Bay Region.

A review of historical data supports the conclusions of the current research. Recommendations were made for complementary investigations which could provide additional evidence for further characterizing stations of concern.

Unresolved issues from earlier studies

Although an attempt was made to gain complete information on the most important sites during the original study, some sites did not receive a full suite of analyses due to budgetary or programmatic constraints. After analysis of the original data set, eight sites were identified as probable areas of concern based on existing information, but appropriate prioritization could not be accomplished because of one or more types of missing data (Table 1). These sites were revisited and samples collected to obtain additional information regarding chemical, toxicological and benthic community conditions. This information was needed to better evaluate the station's priority for future investigation.

Los Penasquitos Lagoon (95006), which was visited during a study of southern California estuaries, exhibited strong toxic responses in bioassays and was determined to have a degraded benthic community (Anderson *et al*, 1997). However, no associated elevated chemical levels were indicated. The possibility existed at this site that pollutants were present that were not included in the normal suite of analyses or that toxicity was a result of non-anthropogenic effects. A toxicity identification evaluation (TIE) was proposed for the current study to

Table 1. Stations to be Revisited

Station #	Station	IDORG	Previous Results
90007.0	25 Swartz (Naval Base O10)	1673	Single toxicity, elevated chem, previous degraded benthics
90008.0	27 Swartz (Naval Base O13)	1674	Single toxicity, previously degraded benthics, low chem
90022.0	P Swartz (Naval Base O12)	1675	Single toxicity, previously degraded benthics, moderate chem
90039.0	Cl	1676	Single toxicity, elevated chem, benthics not analyzed
93179.0	Naval Shipyards O3	1677	Repeated toxicity, elevated chem, Adjacent site degraded benthics
90020.0	G De Lappe	1678	Elevated chem, marginal toxicity, benthics not analyzed
93178.0	Naval Shipyards O2	1679	Elevated chem, marginal toxicity, benthics not analyzed
95006.0	Los Penasquitos (319)	1681	Repeated toxicity, low chem, degraded benthics
90013.0	37 Swartz (Marina)	1680	Reference Site

evaluate the source of this toxic response. A TIE was designed to evaluate pore water toxicity using the *Strongylocentrotus purpuratus* larval development test and the *Eohaustorius estuarius* 10 day survival test.

Figure 1 shows sample locations for the eight revisited stations in San Diego Bay and the TIE station in Los Penasquitos Lagoon.

Data reported for the P-450 Reporter Gene System responses in the appendix of the original report were mismatched against station numbers. This error is corrected in the appendix of this report and stations are correctly matched .

METHODS

Methods for sample collection and processing, trace metal analysis, trace organic analysis, total organic carbon analysis, grain size analysis and benthic community taxonomy are identical to those described in the original San Diego report (Fairey *et al*., 1996). Methods for toxicity have been modified slightly and are described in the following section. Methods for TIE analysis also are described in the following section.

Toxicity Testing

Toxicity testing for this study utilized slightly different protocols than were used for the previous San Diego Bay study. Solid phase testing used the estuarine amphipod *Eohaustorius estuarius* due to concerns that *Rhepoxynius* might be sensitive to fine grained sediments at

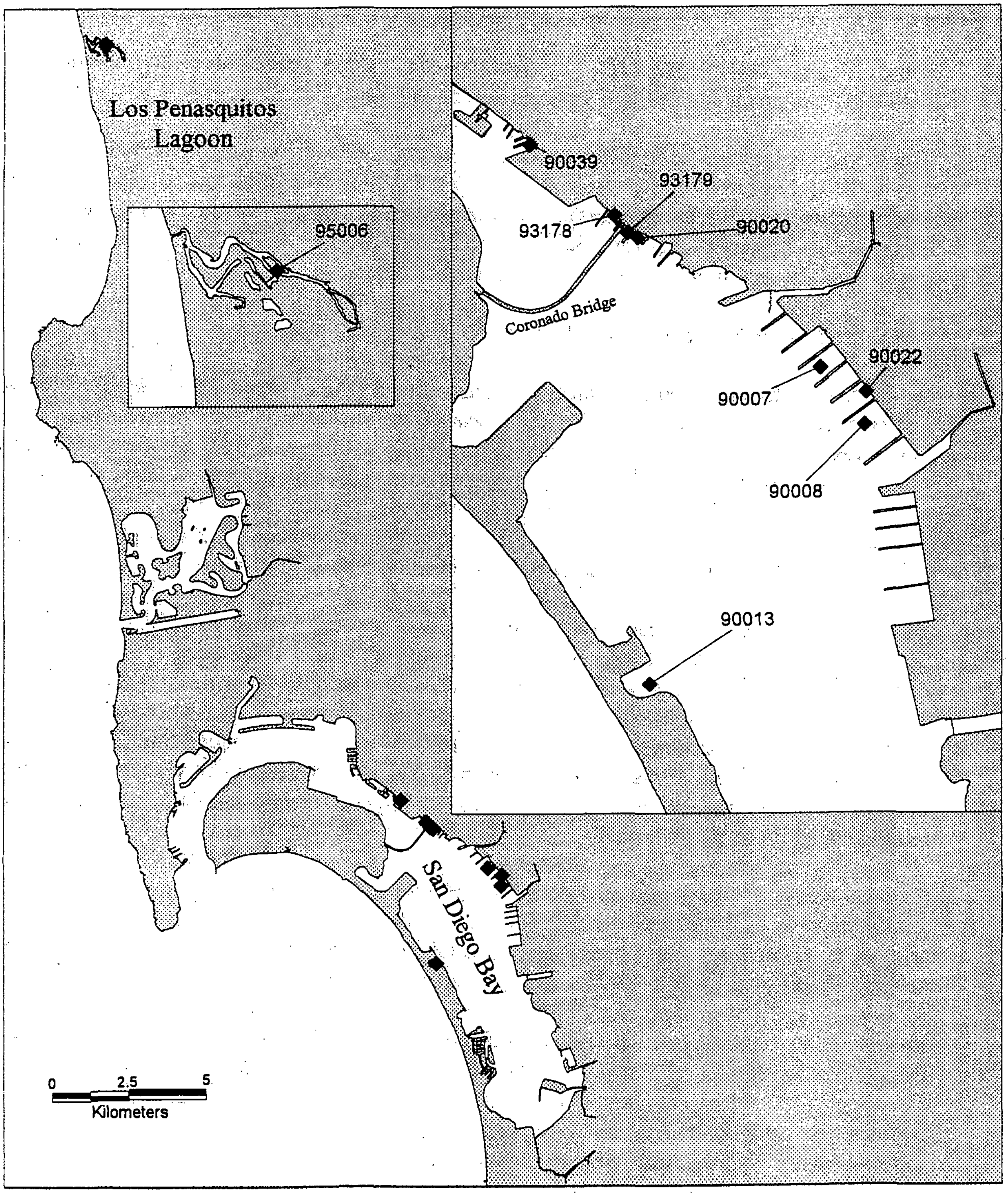


Figure 1. San Diego Bay Region Study Area and Sampling Sites.

some of the stations investigated. Test protocols for the two species are nearly identical with only salinity adjustments being of note, as described below.

The sea urchin larval development test was conducted on sediment pore water samples for the previous San Diego bay study. Recent research using this protocol has indicated that exposure of developing embryos at the interface between sediment and water provides a more ecologically relevant bioassay for this species (Anderson *et al*, 1997). The current study utilized the sediment water interface exposure, as described below.

Amphipod Solid Phase Survival Tests

Solid-phase sediment sample toxicity was assessed using the 10-day amphipod survival toxicity test protocols outlined in EPA 1994. All *Eohaustorius estuarius* were obtained from Northwestern Aquatic Sciences in Yaquina Bay, Oregon. Animals were separated into groups of approximately 100 and placed in polyethylene boxes containing Yaquina Bay collection site sediment, then shipped on ice via overnight courier. Upon arrival at Granite Canyon, the *Eohaustorius* were acclimated to 20‰ (T=15°C). Once acclimated, the animals were held for an additional 48-hours prior to addition to the test containers.

Test containers were one liter glass beakers or jars containing 2-cm of sediment and filled to the 700-ml line with control seawater adjusted to the appropriate salinity using spring water or distilled well water. Test sediments were not sieved for indigenous organisms prior to testing although at the conclusion of the test, the presence of any predators was noted and recorded on the data sheet. Test sediment and overlying water were allowed to equilibrate for 24 hours, after which 20 amphipods were placed in each beaker along with control seawater to fill test containers to the one-liter line. Test chambers were aerated gently and illuminated continuously at ambient laboratory light levels.

Five laboratory replicates of each sample were tested for ten days. A negative sediment control consisting of five lab replicates of Yaquina Bay home sediment for *Eohaustorius* was included with each sediment test. After ten days, the sediments were sieved through a 0.5-mm Nitex screen to recover the test animals, and the number of survivors was recorded for each replicate.

Positive control reference tests were conducted concurrently with each sediment test using cadmium chloride as a reference toxicant. For these tests, amphipod survival was recorded in three replicates of four cadmium concentrations after a 96-hour water-only exposure. A negative seawater control consisting of one micron-filtered Granite Canyon seawater, diluted to the appropriate salinity, was compared to all cadmium concentrations.

Amphipod survival for each replicate was calculated as:

$$\frac{\text{(Number of surviving amphipods)}}{\text{(Initial number of amphipods)}} \times 100$$

Sea Urchin Embryo-Larval Development Test using the Sediment-Water Interface Exposure System

The purple sea urchin (*Strongylocentrotus purpuratus*) embryo/larval development test at the sediment-water interface was conducted on intact core sediment samples taken with minimal disturbance from the Van Veen grab sampler. Details of the test protocol are given in the MPSL Standard Operating Procedure, which follows the EPA methods manual (1995). A brief description of the method follows.

Sea urchins were collected from the Monterey County coast near Granite Canyon, and held at MPSL at ambient seawater temperature and salinity until testing. Adult sea urchins were held in complete darkness to preserve gonadal condition. On the day of the test, urchins were induced to spawn in air by injection with 0.5 ml of 0.5M KCl. Eggs and sperm collected from the urchins were mixed in seawater at a 500 to 1 sperm to egg ratio, and embryos were distributed to the test containers within one hour of fertilization. Sediment-water interface test containers consisted of a polycarbonate tube with a 25-µm screened bottom placed so that the screen was within 1-cm of the surface of an intact sediment core (Anderson *et al.* 1996). Seawater at ambient salinity was poured into the core tube and allowed to equilibrate for 24 hours before the start of the test. After inserting the screen tube into the equilibrated cores, each tube was inoculated with approximately 250 embryos. The laboratory control consisted of Yaquina Bay amphipod home sediment from Northwestern Aquatic Sciences. Tests were conducted at ambient seawater salinity ± 2‰. Ambient salinity at Granite Canyon is usually 32 to 34‰. A positive control reference test was conducted concurrently with the test using a dilution series of copper chloride as a reference toxicant.

After an exposure period of 96 hours, larvae were fixed in 5% buffered formalin. One hundred larvae in each container were examined under an inverted light microscope at 100x to determine the proportion of normally developed larvae as described in EPA 1995. Percent normal development was calculated as:

$$\frac{\text{Number of normally developed larvae counted}}{\text{Total number of larvae counted}} \times 100$$

Determination of Toxicity

Determination of toxicity to amphipods relied on the reference envelope approach described previously (Fairey *et al.*, 1996). In determination of toxicity for the reference envelope approach, values must be chosen for alpha and the percentile (p) to calculate the edge of the reference envelope (L) using the following equation:

$$L = X_r - [\, g_{a,p,n} * S_r \,]$$

The values of alpha and p are chosen to express the degree of certainty desired when classifying a sample as toxic. In this study values of alpha=.05 and p=1 were used to distinguish the most toxic samples which have a 95% certainty of being in the most toxic 1% . This calculation resulted in a determination of toxicity for the *Rhepoxynius* test when samples had a mean survival of less than 48%. This cutoff is as a statistical determination chosen as a conservative guideline for setting priorities for future work, by identifying only the most toxic stations. This same determination of toxicity was applied to the *Eohaustorius* test assuming exposure routes and sensitivities were similar for the two species.

Determination of toxicity to urchin larvae using the sediment water interface exposure was made by comparisons to laboratory controls. Samples were defined as significantly more toxic than laboratory controls if the following two criteria were met: 1) a separate-variance t-test determined there was a significant difference ($p<0.05$) in mean toxicity test organism response (e.g., percent survival) between the sample and the laboratory control and 2) mean organism response in the toxicity test was lower than a certain percentage of the control value, as determined using the 90th percentile Minimum Significant Difference (MSD).

Statistical significance in t-tests is determined by dividing an expression of the difference between sample and control by an expression of the variance among replicates. A "separate variance" t-test that adjusted the degrees of freedom was used to account for variance heterogeneity among samples. If the difference between sample and control is large relative to the variance among replicates, then the difference is determined to be significant. In many cases, however, low between-replicate variance will cause the comparison to be considered significant, even though the magnitude of the difference can be small. The magnitude of difference identified as significant is termed the Minimum Significant Difference (MSD) which is dependent on the selected alpha level, the level of between-replicate variation, and the number of replicates specific to the experiment. With the number of replicates and alpha level held constant, the MSD varies with the degree of between-replicate variation. The "detectable difference" inherent to the toxicity test protocol can be determined by identifying the magnitude of difference detected by the protocol 90% of the time (Schimmel *et al.*, 1991; Thursby and Schlekat, 1993). This is equivalent to setting the level of statistical power at 0.90 for these comparisons. This is accomplished by determining the MSD for each t-test conducted, ranking them in ascending order, and identifying the 90th percentile MSD, the MSD that is larger than or equal to 90% of the MSD values generated.

Current BPTCP detectable difference (90th percentile MSD) for the urchin SWI test is 59% of controls, based on an evaluation of 109 samples. Samples with toxicity test results lower than the values given, as a percentage of control response, would be considered toxic if the result also was significantly different from the control in the individual t-test.

Toxicity Identification Evaluations (TIEs)

Phase I TIEs were designed to characterize samples by isolating broad classes of compounds to determine their relationship to observed toxicity. Phase I TIE procedures include adjustment of sample pH, chelation of cationic compounds (including many trace metals), neutralization of oxidants (such as chlorine), aeration to remove volatiles, inactivation of metabolically activated toxicants, solid-phase extraction (SPE) of non-polar organic compounds on C-18 columns, and subsequent elution of extracted compounds. Each sample fraction, in which classes of compounds have been removed, inactivated, or isolated, then is tested for toxicity. TIE procedures followed the methods described by US EPA (1996).

AVS/SEM Methods

Samples were prepared for Acid Volatile Sulfide (AVS) extraction by weighing a 2 gram sediment sample into a pre-weighed Teflon® bomb. Samples were diluted with 100 ml of oxygen-free MilliQ® water and bubbled with nitrogen gas for 10 minutes. AVS in the sample was converted to hydrogen sulfide gas (H_2S) by acidification with 20 ml of 6 M hydrochloric acid at room temperature. The H_2S was then purged from the sample with nitrogen gas and trapped in 80 ml of 0.5 M sodium hydroxide. The amount of sulfide that has been trapped is then determined by colorimetric methods. The Simultaneously Extracted Metals (SEM) are selected metals liberated from the sediment during the acidification procedure. SEM analysis is conducted with 20 ml of centrifuged sample supernatant taken after AVS extraction. The H_2S released by acidifying the sample is quantified using a colorimetric method:

Hydrogen sulfide is trapped in 80 ml of 0.5M NaOH. Ten ml of this solution is added to a 100 ml volumetric flask containing 70 ml of sulfide-free 0.5M NaOH, 10 ml of MDR reagent and 10 ml of DI water. The sulfide reacts with the N-N-dimethyl-p-phenylenediamine in the MDR reagent to form methylene blue. Absorbances are determined with a Milton Roy Spectronic 301 Spectrophotometer and compared to a standardized curve.

Table 2. AVS/SEM Analytes and Detection Limits

Analytes	*µmol/g*	*µg/g*
Cadmium	0.0001	0.01
Copper	0.02	1.0
Lead	0.001	0.1
Nickel	0.002	0.1
Zinc	0.001	0.05
Sulfide	0.5	n/a

RESULTS AND DISCUSSION

Tabulated data for all chemical, toxicological and benthic community analyses are detailed in the Appendices. The following section presents summarized data that highlights significant findings from analysis of the full data set.

Revised P450 Data

Appendix E in the original report incorrectly reported data for total PAHs when compared to P450 response at all stations sampled. It should be noted that the correct values were used for all data analyses so data interpretations were not affected by this error. Appendix G in the current report presents revised data to correct the earlier appendix error.

Chemistry

Individual chemical concentrations were compared to ERM and PEL sediment quality guidelines. These guidelines are used to indicate samples with a high probability of demonstrating biological effects (Lon and Morgan, 1990; MacDonald, 1994; Long *et al.*, 1995; Long and MacDonald, in press). Chemical analysis was not performed on the sample from Los Penasquitos Lagoon in this study, so no comparisons to guidelines were made. Sediment quality guidelines were exceeded at all San Diego Bay stations and the number of guideline exceedances was high at most stations (Table 3). Chlordane, PAHs and PCBs were the pollutants most often found at elevated concentrations at these stations. Copper, lead, mercury and zinc were often found at elevated levels in the Naval Shipyard areas, although SEM/AVS ratios indicate the probability of metal toxicity is low. This is consistent with previous results demonstrating elevated chemical concentrations at several of these stations. Findings in this study also support the selection of the reference station (90013) as representative of current background chemical conditions in San Diego Bay.

Chemical summary quotients were utilized by the San Diego Bay study to evaluate multiple chemical pollutants in samples within the San Diego Bay region. Eight sediment samples received extensive chemical analyses during the current study, allowing for calculation of summary quotients (Table 3). This approach has been used previously in the BPTCP to identify elevated chemical levels in the San Diego Bay region (Fairey *et al.*, 1996), based on evaluation of 220 sediment samples. Upper 90th percentile summary quotients for that data set were ERMQ>0.85 and PELQ>1.29, respectively. Although these values cannot be considered threshold levels with proven ecological significance, they can be used for comparative purposes to indicate the worst 10 % of the samples in the region, with respect to pollutant concentrations. These 90th percentile values were used in the current study to help identify areas of concern for the region based on comparisons to the earlier larger data set. Five of eight samples in the current study exceeded these ERMQ and PELQ percentiles demonstrating elevated multiple pollutants at these stations.

Table 3. Chemical Summary Quotient Values and Sediment Quality Guideline Exceedances

Station #	Station	IDORG	ERMQ	PELQ	> ERMs	>PELs
90007.0	25 Swartz (Naval Base O10)	1673	0.646	0.944	3	15
90008.0	27 Swartz (Naval Base O13)	1674	0.532	0.835	1	13
90022.0	P Swartz (Naval Base O12)	1675	0.958	1.398	13	19
90039.0	Cl	1676	2.180	3.785	7	20
93179.0	Naval Shipyards O3	1677	2.483	2.227	16	20
90020.0	G De Lappe	1678	2.028	2.463	12	17
93178.0	Naval Shipyards O2	1679	1.526	1.875	8	16
90013.0	37 Swartz (Marina)	1680	0.280	0.407	0	2
95006.0	Los Penasquitos (319)	1681	n/a	n/a	n/a	n/a

Use of chemical summary quotients also allows comparisons to be made between regions within the state and demonstrate that the San Diego Bay region has relatively greater pollutant levels compared to more pristine settings in northern and central California. The greatest quotient values for the north coast of California (ERMQ=0.243; PELQ=0.528) (Jacobi *et al.*, in prep) and for the central coast of California (ERMQ=0.447; PELQ=0.735)(Downing *et al.*, in prep) are considerably lower than those in the upper 10% from San Diego Bay. This is to be expected because the north coast and central coast are not as heavily populated or industrialized as the urban areas of southern California. This comparison is useful though by giving insight to the range of pollution that is represented in the state and that samples from San Diego Bay often fall within the upper end (most polluted) of the range.

Long and MacDonald (in press) further examined the use of sediment quality guidelines and the probability of toxicity being associated with summary quotient ranges. This extensive national study developed four sediment categories to help prioritize areas of concern, based on the probability of toxicity associated with summary quotients and number of individual ERM/PEL guideline exceedances. Sediments with ERM quotients > 0.51 or PEL quotients >1.5, or more than 5 guideline exceedances, were generally assigned to categories of elevated concern (medium high to high priority) because the probability of associated toxicity was greater than 50%. Five sediment samples from the current San Diego Bay study exceed these thresholds. Three of these five sediment samples demonstrated ERM quotients > 1.5 or PEL quotients >2.3 and fall within the survey's highest category. Nationwide, samples in this range were assigned the highest priority as sites of concern, based on a probability of toxicity to amphipods of >74%, and should further highlight the concern for these stations within the region. It should be noted that current BPTCP calculation methods of summary quotients vary slightly from the national study based on incorporation of a modified suite of chemicals. These modifications were incorporated because the predictability of toxicity is enhanced thus providing stronger evidence of the value of this multiple chemical indicator of biological effects.

Toxicity

Station CL (90039) exhibited toxicity to the amphipod *Eohaustorius*, based on comparison to the reference envelope (<48% survival) (Figure 2; Table 4). Samples from the remaining stations were not toxic to amphipods. Unionized ammonia concentrations in these bioassays were all below the application limit (0.8 mg/L; EPA, 1995) and likely did not contribute to observed toxicity. Hydrogen sulfide (H_2S) concentrations were well above the observed "low effects" level (0.114 mg/L; Knezovich, 1996) for three samples, including station CL (90039). H_2S might have contributed to toxicity at this station, but this seems unlikely because the H_2S concentration in the sample from station Naval Shipyard O2 (93178) was over twice as high without demonstrating toxicity.

Determination of toxicity to urchin development is based on t-test and comparison to the MSD as described earlier. Three stations exhibited toxicity to urchins in the SWI exposure (Figure 2; Table 4). Ammonia levels in these bioassays were all below the "no effects" level (0.07 mg/L; Bay, 1993) and likely did not contribute to observed toxicity. H_2S concentrations were above the observed "low effects" level (0.0076 mg/L; Knezovich, 1996) for four samples, three of which exhibited a toxic response. H_2S might have contributed to toxicity at both of these stations, but this seems unlikely at the Naval Shipyard (93178) or P Swartz (90022) stations because greater sulfide levels were measured in the 25 Swartz (90007) sample with no

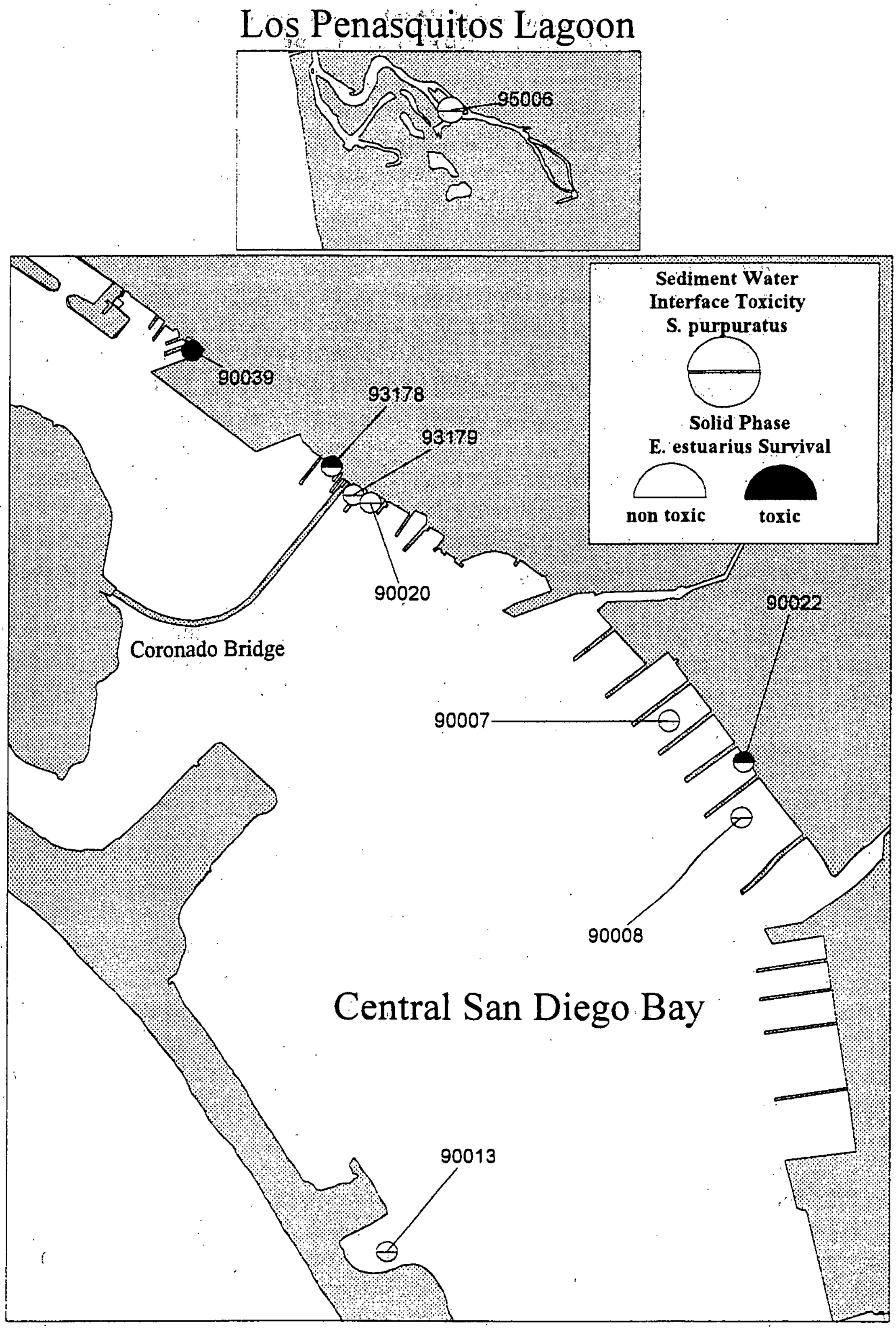


Figure 2. San Diego Bay Region Toxicity. Samples were toxic if significantly different from controls using a t-test and less than control based MSD values (see text for complete toxicity definition).

concurrent toxic effect. The concentration of H_2S in the other toxic sample (CL, 90039) should be considered as a potential confounding factor.

Only one station (CL, 90039) demonstrated concurrent toxicity to both amphipods and urchins .

Toxicity was not exhibited in the pore water sample from Los Penasquitos Lagoon. This was contrary to expectations based on two previous visits to this site. Because the initial test was not toxic, TIE analysis was not carried out using *Strongylocentrotus purpuratus*, but was initiated using *Eohaustorius estuarius* as a precautionary measure. No toxic effect was measured at any level for this test so the TIE investigation was abandoned.

Table 4. Toxicity Test Results for Amphipods (EE) and Urchins (SPDI)

Station #	Station	IDORG	EE	NH_3	H_2S	SPDI	NH_3	H_2S
90007.0	25 Swartz (Naval Base O10)	1673	87	<MDL	0.008	76	0.008	**0.050**
90008.0	27 Swartz (Naval Base O13)	1674	91	0.008	<MDL	94	0.003	0.006
90022.0	P Swartz (Naval Base O12)	1675	83	0.003	0.007	**43**	0.004	**0.008**
90039.0	Cl	1676	**22**	0.056	**0.269**	**38**	0.001	**0.277**
93179.0	Naval Shipyards O3	1677	87	0.007	0.007	74	<MDL	0.002
90020.0	G De Lappe	1678	66	0.064	0.050	57	0.003	0.001
93178.0	Naval Shipyards O2	1679	88	0.042	**0.646**	**2**	0.010	**0.016**
90013.0	37 Swartz (Marina)	1680	83	0.020	**0.173**	78	0.010	0.007
95006.0	Los Penasquitos (319)	1681	84	0.069	0.071	67	0.004	0.005

Bolded values indicate samples that were toxic or exceeded water quality effects thresholds

Benthic Community Degradation

Results of all benthic community analyses conducted as part of this study are presented in tables in Appendix F. These tables show the species, taxa, number of individuals per core, and summary statistics for the 8 stations sampled.

The current study utilizes a Relative Benthic Index (RBI) based on modification of indices used in San Diego (Fairey *et al.*, 1996) and in southern California (Anderson *et al.*, 1997). The San Diego study had 75 samples for which the indices were derived and used a number of techniques to generate categorical community classifications as degraded, transitional or undegraded. The southern California study contained 43 samples and was a modified version of the earlier San Diego evaluation. The modification was primarily based on quantifying community classifications on a graduated scale from 0 to 1. The Relative Benthic Index used in this study incorporates refinements from both previous studies and quantifies community health on a graduated scale of 0 to 1. It combines use of benthic community data with the presence or absence of positive and negative indicator species in order to provide a measure of the relative degree of degradation within the benthic fauna. The index does not require the presence of an uncontaminated reference station and relies on the larger data set from the 1996 San Diego study to establish high and low ranges for the region. Because of small sample size (n=8) the current index is not based on samples collected exclusively during the current study. The RBI however does provide the relative "health" of each of the stations in the current data set compared to stations from the previous data set.

The Relative Benthic Index for the current 8 samples region ranged between 0.02 and 1.0 (Table 5). Stations with greater numbers of negative indicator species, such as polychaetes and oligochaetes, in association with low species diversity generally denote an area of disturbance and score lower with the index. In contrast, stations with a greater number of positive indicator species, such a gammarid amphipods or ostracods, and higher species diversity indicate a relatively undisturbed area with a mature benthic community and score higher with the index. Selection of indicator species is based on the best professional judgement of benthic ecologist familiar with species in the region. Four stations with a RBI ≤ 0.3 were classified as having degraded benthic communities (Figure 3). Three stations were classified as having transitional benthic communities (characteristics of both healthy and impacted communities; 0.3≤ RBI ≤ 0.6) and one station was classified as undegraded (RBI>0.6). The undegraded station was selected for this study as a reference site due to previously determined low chemical concentrations and undegraded benthic community. Findings in the current study support the selection of this station as representative of reference conditions.

Table 5. Relative Benthic Index (RBI) Values

Station #	Station	IDORG	RBI
90007.0	25 SWARTZ (NAVAL BASE O10)	1673	0.16
90008.0	27 SWARTZ (NAVAL BASE O13)	1674	0.24
90022.0	P SWARTZ (NAVAL BASE O12)	1675	0.38
90039.0	CL	1676	0.02
93179.0	NAVAL SHIPYARDS O3	1677	0.42
90020.0	G DE LAPPE	1678	0.29
93178.0	NAVAL SHIPYARDS O2	1679	0.41
90013.0	37 SWARTZ (MARINA)	1680	1.00
95006.0	LOS PENASQUITOS (319)	1681	n/a

Station Specific Sediment Quality Assessments

Sediment samples from each of the stations in San Diego Harbor were analyzed for chemical concentration, toxicity and benthic community structure. This synoptic study design allows for the assessment of sediment quality using a complementary weight of evidence from observed biological effects and potential pollutants. Prioritizations were made to help focus RWQCB and SWRCB staff on sediments that pose a threat to the water body. Assessments followed those of the previous San Diego Region report by relying on the combination and severity of environmental measures to categorize stations as a high, moderate, or low priority. Sediments that exhibited strong toxic responses, and/or degraded resident communities, and were associated with identifiable pollutants, were given the highest priority for further investigation. Sediments with reduced or negligible responses were given lower priorities for investigation or recommended for no further action. Limited personnel and resources can therefore be focused on sediments that most likely pose a threat to the environment in San Diego Bay.

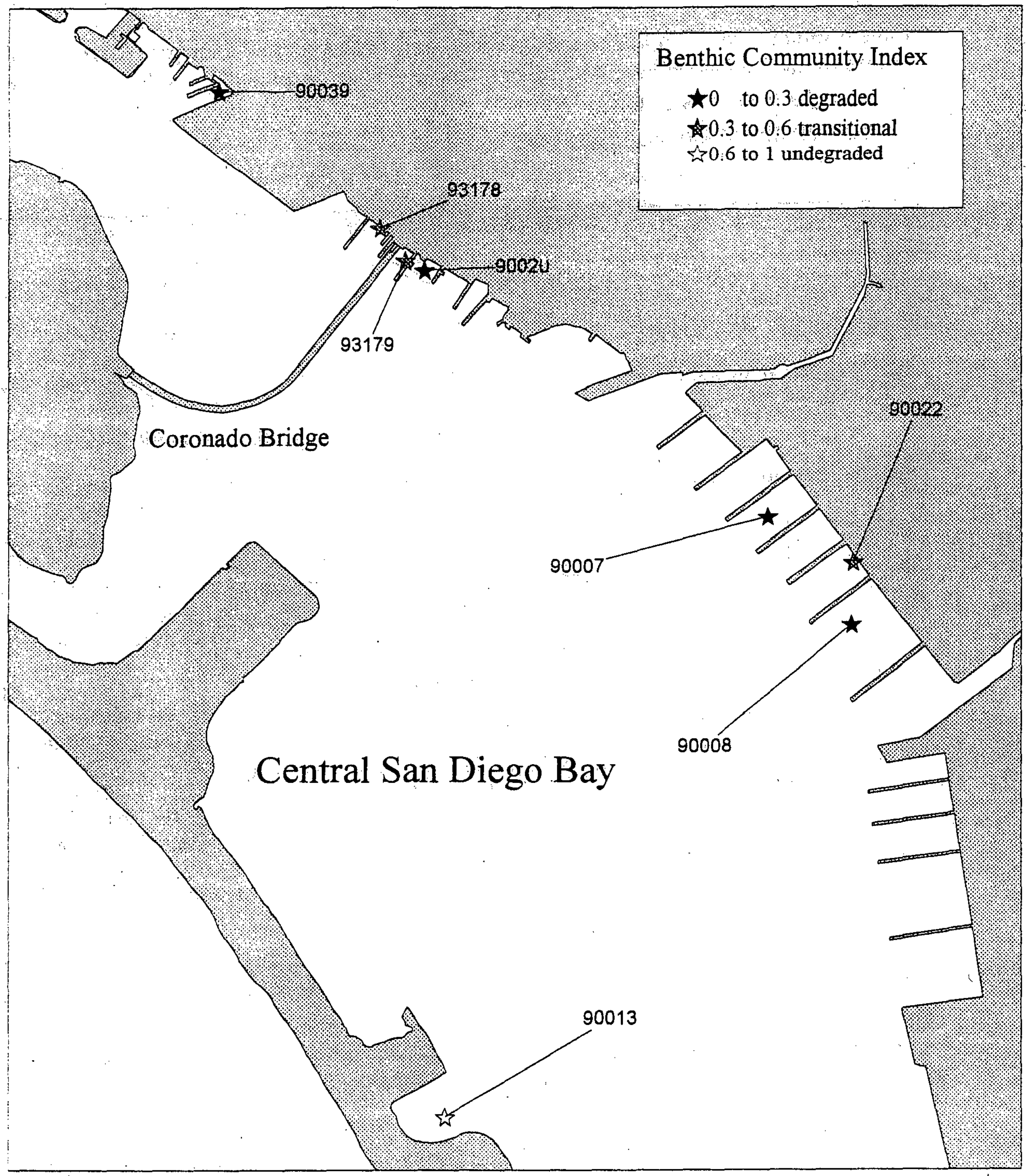


Figure 3. San Diego Bay Region Benthic Community Indices.

Table 6 summarizes chemical concentrations, toxicity and benthic community structure for the eight stations sampled in San Diego Bay. Comments summarize the weight of evidence at each station and a priority is assigned for future investigation. The locations and priority categories for each station are shown in Figure 4.

Table 6. Station Prioritization

Station #	Station	IDORG	ERMQ	PELQ	EE	SPDI	RBI	Comments	Priority
90039.0	CL	1676	**2.14**	**3.79**	**22**	**38**	**0.02**	Elevated Chem. Toxicity Degraded Comm.	High
93178.0	Naval Shipyards O2	1679	**1.37**	**1.88**	88	**2**	0.41	Elevated Chem. Toxicity Transitional Comm.	Moderate
90022.0	P Swartz (Naval O12)	1675	**0.86**	**1.40**	83	**43**	0.38	Elevated Chem. Toxicity Transitional Comm.	Moderate
90020.0	G De Lappe	1678	**1.84**	**2.46**	66	57	**0.29**	Elevated Chem. No Toxicity Degraded Comm.	Moderate
93179.0	Naval Shipyards O3	1677	**1.55**	**2.23**	87	74	0.42	Elevated Chem. No Toxicity Transitional Comm.	Moderate
90007.0	25 Swartz (Naval O10)	1673	0.59	0.94	87	76	**0.16**	Chem. Not Elevated No Toxicity Degraded Comm.	Low
90008.0	27 Swartz (Naval O13)	1674	0.49	0.84	91	94	**0.24**	Chem. Not Elevated No Toxicity Degraded Comm.	Low
90013.0	37 Swartz (Marina)	1680	0.23	0.40	83	78	1.00	Chem. Not Elevated No Toxicity Undegraded Comm.	No action

Bolded values indicate samples that were toxic or exceeded BPTCP thresholds

Station CL (90039) was assigned the highest priority. This station was given a moderate priority in the previous report because benthic community analysis had not been performed and only one toxic response had been observed. The sample collected at this station during the current study again exhibited toxicity to amphipods and urchin larvae, elevated chemicals, particularly pesticides and PAHs, and a degraded resident benthic community. The station is located at the mouth of Switzer Creek where a concrete culvert empties into the bay.

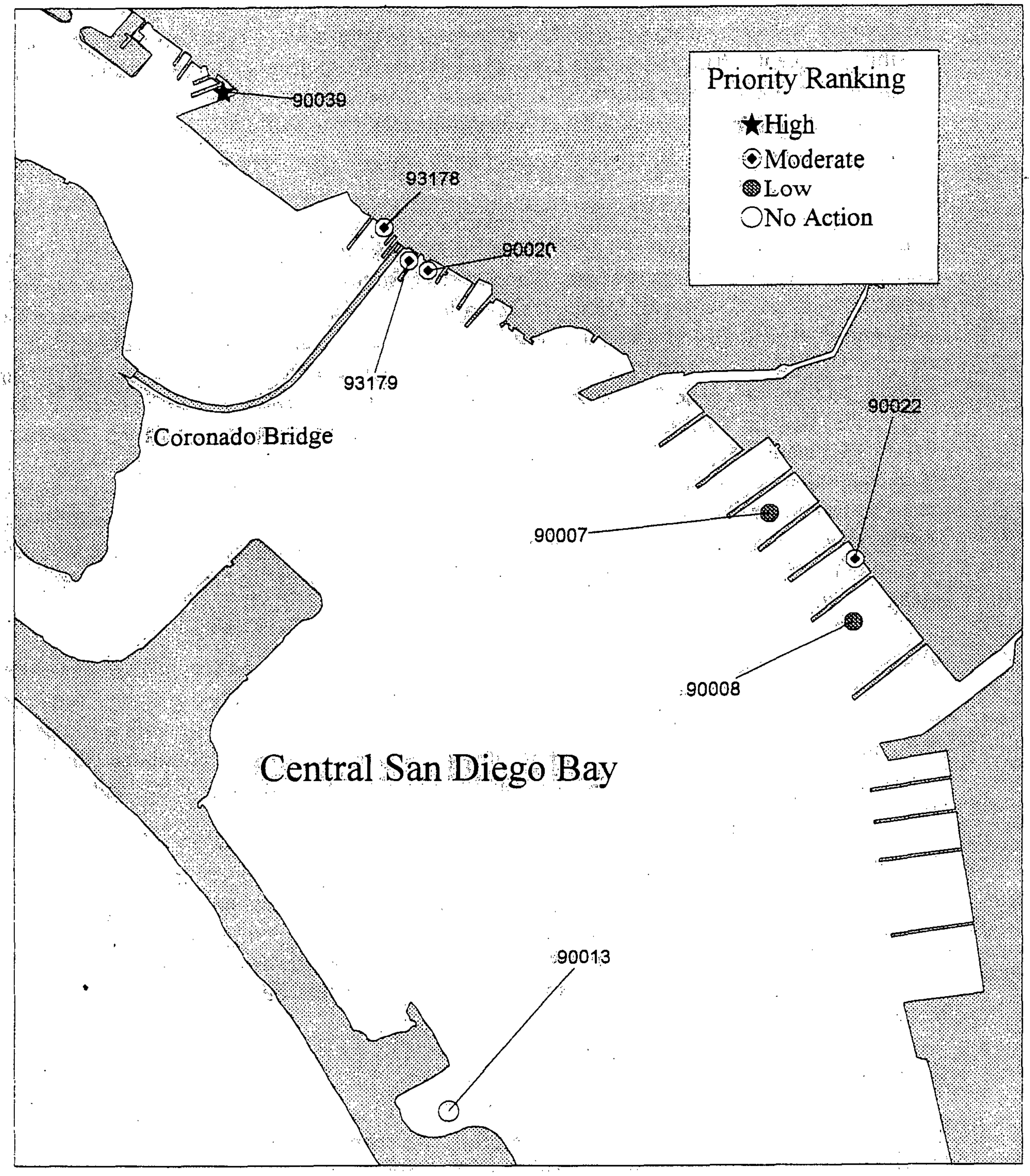


Figure 4. San Diego Bay Region Priority Ranking.

Historically this area served as a PAH waste dump site for a San Diego Gas and Electric coal gasification plant. Prior to that the site served as one of the original garbage dumps in the San Diego region (Port of San Diego, 1996). Pesticide residues and organic matter were prevalent in the sediment samples and indicate a probable link to urban and storm runoff. Moving this station to higher priority is strongly supported by evidence gathered in the current and previous study.

Three stations were assigned to a moderate priority category based on elevated chemical levels and one measure of biological effect. Each of these stations is in an area of current or past ship repair operations. The Naval Shipyard O2 station (93178), just north of the Coronado Bridge and near Continental Maritime, represents an area which has served as a ship repair facility for the past ten years and prior to that was the location of a tuna cannery. PCBs are the principal pollutant at this site. The P Swartz (90022) station is in the Naval Shipyard between Piers 5 and Pier 6, near the mouth of the Graving Dock. Ship repair activities are a likely source of PAHs, PCBs and copper which were the prominent pollutants at the site. Station G De Lappe (90020) is located just south of the Coronado Bridge, near Southwest Marine, where industrial and shipping activities have been in operation for many years. Sources of elevated PCBs and PAHs in samples may be from commercial activities or from fill material that was added along the shoreline in the past. Each of these stations received a moderate priority in the previous study and the current study supports this prioritization.

One station was assigned to a moderate priority category based on an inconclusive measure of biological effects. The Naval Shipyards O3 station (93179) was assigned a high priority in the previous study based on elevated chemistry, presence of toxicity, and degradation of the benthic community at an adjacent station. In the current study lack of toxicity, continued elevated chemistry and a transitional benthic community prompted re-assignment of this station to the moderate category.

Stations 25 Swartz (90007) and 27 Swartz (90008) were assigned moderate priorities in the previous study based on moderate chemical levels, a single toxic response and a degraded benthic community at an adjacent station. Data from the current study indicated low to moderate chemical levels, however toxicity was absent. The benthic communities were classified as degraded, but unclear association of elevated chemicals prompted re-classification of these two stations to a lower priority.

CONCLUSIONS

The current study was designed to better evaluate sediment quality at eight stations within San Diego Harbor where missing or inconclusive data from a previous study confounded interpretations. Collection of synoptic chemical, toxicological and benthic community data provided the needed information to prioritize these stations, utilizing a strong weight of evidence approach. This approach helped identify stations with sediments that have a high probability of causing adverse environmental impacts. A significant limitation of this study is the inability to directly link cause and effect or to delineate the boundaries of the impacted area.

Subsequent studies will be required to address these critical issues. The current study does, however, help focus future management efforts on the stations of greatest concern.

The investigation of toxicity at Los Penasquitos Lagoon was terminated when initial tests revealed that samples were not toxic. Low levels of measured chemicals in the previous study and the transitory nature of toxicity at this location make it difficult to attribute a cause to the observed effects. No further action is recommended for this location.

REFERENCES

Anderson, B., J. Hunt, S. Tudor, J. Newman, R. Tjeerdema, R Fairey, J. Oakden, C. Bretz, C. Wilson, F. La Caro, G. Kapahi, M.Stephenson, M. Puckett, J. Anderson, E. Long, and T. Flemming. 1997. Chemistry, toxicity and benthic community conditions in sediments of selected southern California bays and estuaries. Final Report. California State Water Resources Control Board. Sacramento, CA.

Anderson, B., J. Hunt, M. Hester, and B. Phillips. 1996. Assessment of sediment toxicity at the sediment-water interface. *In* Techniques in Aquatic Toxicology, G.K. Ostrander (ed). Lewis Publishers: Ann Arbor, MI.

Bay, S., R. Burgess, and D. Greenstein. 1993. Status and applications in the Echinoid (Phylum Echinodermata) toxicity test methods. In: W.G. Landis, J.S. Hughes and M.A. Lewis, eds. Environmental Toxicology and Risk Assessment. ASTM, STP 1179, Philadelphia, PA.

Downing, J., R. Fairey, C. Roberts, E. Landrau, R. Clark, J. Hunt, B. Anderson, B. Phillips, C. Wilson, F. La Caro, G. Kapahi, K. Worcester, M. Stephenson, and M. Puckett. 1998 (in prep.). Chemical and biological measures of sediment quality in the Central Coast Region. Draft Report. California State Water Resources Control Board. Sacramento, CA.

Fairey, R., C. Bretz, S. Lamerdin, J. Hunt, B. Anderson, S. Tudor, C. Wilson, F. La Caro, M. Stephenson, M. Puckett, and E. Long. 1996. Chemistry, toxicity, and benthic community conditions in sediments of the San Diego Bay Region. Final Report. California State Water Resources Control Board. Sacramento, CA.

Jacobi, M., R. Fairey, C. Roberts, E. Landrau, J. Hunt, B. Anderson, B. Phillips, C. Wilson, F. La Caro, B. Gwynne, M. Stephenson, and M. Puckett. 1998 (in prep.). Chemical and biological measures of sediment quality and tissue bioaccumulation in the North Coast Region. Draft Report. CA State Water Resources Control Board. Draft Report. Sacramento, CA

Knezovich, J., D. Steichen, J. Jelinski, and S. Anderson. 1996. Sulfide tolerance of four marine species used to evaluate sediment and pore water toxicity. Bull. Environ. Contam. Toxicol. 57:450-457.

Long, E. and D. MacDonald. *In Press*. Recommended uses of empirically-derived, sediment quality guidelines for marine and estuarine ecosystems. Human and Ecological Risk Assessment.

Long, E., J. Field, D. MacDonald. 1998. Predicting toxicity in marine sediments with numerical sediment quality guidelines. Environmental Toxicology and Chemistry 17(4):714-727.

Long, E. , D. MacDonald, S. Smith and F. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental Management 19(1): 81-97.

Long, E. and L. Morgan. 1990. The potential for biological effects of sediment-sorbed contaminants tested in the national Status and Trends Program. NOAA Technical Memorandum NOS OMA 62. National Oceanic and Atmospheric Administration, Seattle, WA. 86 pp.

MacDonald, D. 1994. Approach to the assessment of sediment quality guidelines in Florida coastal waters. Volume 1- Development and evaluation of sediment assessment guidelines. Prepared for the Florida Department of Environmental Regulation. MacDonald Environmental Services, Ltd. Ladysmith, British Columbia. 52 pp.

Port of San Diego. 1996. A Historical Perspective of the Eigth Avenue Tidelands Dump. Environmental Management Department of the San Diego Unified Port District. San Diego, CA.

Thursby, G. and C. Schlekat. 1993. Statistical analysis of 10-day solid phase toxicity data for amphipods. Abstract, 14th Annual Meeting, Society of Environmental Toxicology and Chemistry.

Schimmel, S., B. Melzian, D. Campbell, C. Strobel, S. Benyi, J. Rosen, H. Buffum, and N. Rubenstein. 1991. Statistical summary: EMAP-Estuaries, Virginian Province. EPA/620/R-94/005.

U.S. Environmental Protection Agency. 1996. Marine Toxicity Identification Evaluations (TIE): Phase I Guidance Document. EPA/600/R-96/054. September, 1996. Office of Research and Development. Washington, D.C. U.S.A.

U.S. Environmental Protection Agency. 1995. Short term methods for estimating the chronic toxicity of effluent and receiving waters to west coast marine and estuarine organisms. EPA/600/R-95/136. Office of Research and Development. Washington, D.C., U.S.A.

U.S. Environmental Protection Agency. 1994. EPA. 1994. Methods for assessing the toxicity of sediment-associated contaminants with estuarine and marine amphipods. EPA 600/R-94/025. Office of Research and Development. Washington, D.C. U.S.A.

APPENDIX A

Database Description

I. OVERVIEW OF THE BAY PROTECTION PROGRAM

The California State Water Resources Control Board (SWRCB) has contracted the California Department of Fish and Game (CDFG) to coordinate the scientific aspects of the Bay Protection and Toxic Cleanup Program (BPTCP), a SWRCB program mandated by the California Legislature. The BPTCP is a comprehensive, long-term effort to regulate toxic pollutants in California's enclosed bays and estuaries. The program consists of both short-term and long-term activities. The short-term activities include the identification and priority ranking of toxic hot spots, development and implementation of regional monitoring programs designed to identify toxic hot spots, development of narrative sediment quality objectives, development and implementation of cleanup plans, revision of waste discharge requirements as needed to alleviate impacts of toxic pollutants, and development of a comprehensive database containing information pertinent to describing and managing toxic hot spots. The long-term activities include development of numeric sediment quality objectives; development and implementation of strategies to prevent the formation of new toxic hot spots and to reduce the severity of effects from existing toxic hot spots; revision of water quality control plans, cleanup plans, and monitoring programs; and maintenance of the comprehensive database.

Actual field and laboratory work is performed under contract by the California Department of Fish and Game (CDFG). The CDFG subcontracts the toxicity testing to Dr. Ron Tjeerdema at the University of California at Santa Cruz (UCSC) and the laboratory testing is performed at the CDFG toxicity testing laboratory at Granite Canyon, south of Carmel. The CDFG contracts the majority of the sample collection activities to Dr. John Oliver of San Jose State University at the Moss Landing Marine Laboratories (MLML) in Moss Landing. Dr. Oliver also is subcontracted to perform the TOC and grain size analyses, as well as to perform the benthic community analyses. CDFG personnel perform the trace metals analyses at the trace metals facility at Moss Landing Marine Laboratories in Moss Landing. The synthetic organic pesticides, PAHs and PCBs are contracted by CDFG to Dr. Ron Tjeerdema at the UCSC trace organics facility at Long Marine Laboratory in Santa Cruz. MLML currently maintains the Bay Protection and Toxic Cleanup Database for the SWRCB. Described below is a description of that database system.

II. DESCRIPTION OF COMPUTER FILES

The sample collection/field information, chemical, and toxicity data are stored on hard copy, computer disks and on a 486DX PC at Moss Landing Marine Laboratories. Access is limited to Russell Fairey. Contact Russell Fairey at (408) 633-6035 for copies of data. The data are stored in a dBase 4 program and can be exported to a variety of formats. There are three backups of this database stored in two different laboratories. The data are entered into 1 of 4 files. CHEM1_56.DBF file contains a collection of chemical analyses data in sediments. TOX1_56.DBF file contains toxicity test data and associated water quality data. TISS1_56.DBF file contains a collection of chemical analyses in tissue matrix. BEN1_56.XLS file contains a summary of benthic community analyses. This file is stored in Excel 5.0. A hardcopy printout of the dBase database structure is attached, showing precise characteristics of each field.

The CHEM1_56.DBF file contains the following fields (the number at the start of each field is the field number):

1. STANUM. This numeric field is 7 characters wide with 1 decimal place and contains the CDFG station numbers that are used statewide. The format is YXXXX.Z where Y is the Regional Water Quality Control Board Region number and XXXX is the number that corresponds to a given location or site and Z is the number of the station within that site. An example is San Pablo Bay- Island #1, in San Francisco Bay, where the STANUM is 20007.0. The 2 indicates Region 2. The 0007 indicates it is Site 7 and the .0 is the replicate (if any) at the station within Site 7.
2. STATION. This character field is 30 characters wide and contains the exact name of the station.
3. IDORG. This numeric field is 8 characters wide and contains the unique i.d. organizational number for the sample. For each station collected on a unique date, an idorg sample number is assigned. This should be the field that links the collection, toxicity, chemical, and other databases.
4. DATE. This date field is 8 characters wide and is the date that each sample was collected in the field. It is listed as MM/DD/YY.
5. LEG. This numeric field is 6 characters wide with 1 decimal place, and is the leg number of the project in which the sample was collected.
6. LATITUDE. This character field is 12 characters wide and contains the latitude of the center of the station sampled. The format is a character field as follows: XX,YY,ZZ, where XX is in degrees, YY is in minutes, and ZZ is in seconds or hundreds.
7. LONGITUDE. This character field is 14 characters wide and contains the longitude of the center of the station sampled. The format is a character field as follows: XXX,YY,ZZ, where XXX is in degrees, YY is in minutes, and ZZ is in seconds or hundreds.
8. HUND_SECS. This character field is 3 characters wide and contains the designation "h" if the latitude and longitude are given in degrees, minutes, hundredths of a minute. If differential accuracy was achieved with the GPS at the station the designation is given as "h/d". The designation "s" is given when latitude and longitude are given in degrees, minutes, seconds.
9. GISLAT. This numeric field is 12 characters wide with 8 decimal places and contains the latitude of the station sampled in Geographical Information System format. The format is a numeric field as follows: XX.YYYYYYYY, where XX is in degrees and YYYYYYYY is a decimal fraction of the preceding degree.
10. GISLONG. This numeric field is 14 characters wide with 8 decimal places and contains the longitude of the station sampled. The format is a character field as follows: XXXX.YYYYYYYY where XXXX is in degrees and YYYYYYYY is a decimal fraction of the preceding degree.
11. DEPTH. This character field is 4 characters wide and contains the depth at which the sediment sample was collected, in meters to the nearest one half meter.
12. METADATA. This is a text index directing the user to tables or files of ancillary data pertinent to the associated data file. Character field, width 12.

TRACE METALS IN SEDIMENT are presented in fields 13 through 32. All sediment trace metal results are reported on a dry weight basis in parts per million (ppm).

A. When the value is missing or not analyzed, the value is reported as "-9.0" = not analyzed.
B. When the value is less than the detection limit of the analytical test, the value is reported as "-8.0" = not detected.

Sediment trace metals are numeric fields of varying character width, and including the following elements, listed by field number, then field name as it appears in the database, then numeric character width and number of decimal places:

13. TMMOIST. 6.2
14. ALUMINUM. 9.2
15. ANTIMONY. 7.3
16. ARSENIC. 6.3
17. CADMIUM. 7.4
18. CHROMIUM. 8.3
19. COPPER. 7.2
20. IRON. 7.1
21. LEAD. 7.3
22. MANGANESE. 7.2
23. MERCURY. 7.4
24. NICKEL. 7.3
25. SILVER. 7.4
26. SELENIUM. 6.3
27. TIN. 8.4
28. ZINC. 9.4
29. ASBATCH. 5.1
30. SEBATCH. 5.1
31. TMBATCH. The Batch number that the sample was digested in, numeric field width of 5 with 2 decimal place.
32. TMDATAQC. Data qualifier codes are notations used by data reviewers to briefly describe, or qualify data and the systems producing data, numeric field width 3. Data qualifier codes are as follows:
    A. When the sample meets or exceeds the control criteria requirements, the value is reported as "-4".
    B. When the sample has minor exceedences of control criteria but is generally usable for most assessments and reporting purposes, the value is reported as "-5". For samples coded "-5" it is recommended that if assessments are made that are especially sensitive or critical, the QA evaluations should be consulted before using the data.
    C. When the QA samples has major exceedences of control criteria requirements and the data are not usable for most assessments and reporting purposes, the value is reported as "-6".
    D. When the sample has minor exceedences of control criteria and is unlikely to affect assessments, the value is reported as "-3".

AVS/SEM concentrations are presented in fields 33 through 42. All AVS/SEM results are reported on a dry weight basis in parts per million (ppm or ug/g). Acid volatile sulfides (AVS) and simultaneous extracted metals (SEM) are numeric fields of varying character width, and including the following elements, listed by field number, then field name as it appears in the database, then numeric character width and number of decimal places.

33. AVS. 7.2
34. SEM_CD. 7.4
35. SEM_CU. 7.2
36. SEM_NI. 7.3
37. SEM_PB. 7.3
38. SEM_ZN. 9.4
39. SEM_SUM. 9.4
40. SEM_AVS. 9.3
41. AVS_BATCH. The batch number the sample was extracted in, numeric field width 5.
42. AVSDATAQC. Data qualifier codes are notations used by data reviewers to briefly describe, or qualify data and the systems producing data, numeric field width 3. Data qualifier codes are as follows:
    A. When the sample meets or exceeds the control criteria requirements, the value is reported as "-4".
    B. When the sample has minor exceedences of control criteria but is generally usable for most assessments and reporting purposes, the value is reported as "-5". For samples coded "-5" it is recommended that if assessments are made that are especially sensitive or critical, the QA evaluations should be consulted before using the data.
    C. When the QA samples has major exceedences of control criteria requirements and the data are not usable for most assessments and reporting purposes, the value is reported as "-6".
    D. When the sample has minor exceedences of control criteria and is unlikely to affect assessments, the value is reported as "-3".

SYNTHETIC ORGANICS are presented in fields 43 through 162. All synthetic organic results are reported on a dry weight basis in parts per billion (ppb or ng/g).

A. When the value is missing or not analyzed, the value is reported as "-9.0" = not analyzed.
B. When the value is less than the detection limit of the analytical test, the value is reported as "-8.0" = not detected.

Synthetic organics are reported on a dry weight basis in parts per billion (ppb or ng/g) and are numeric fields of varying width, and include the following compounds, listed by field number, then field name as it appears in database (and followed by the compound name if not obvious), and then finally, the numeric character width and number of decimal places is given:

43 SOWEIGHT. This numeric field is 6 characters wide with 2 decimal places and contains the weight of the sample extracted for analysis.
44 SOMOIST. This numeric field is 6 characters wide with 2 decimal places and contains the percent moisture of the sample extracted.
45 ALDRIN. 9.3

46 CCHLOR. cis-Chlordane. 9.3
47 TCHLOR. trans-Chlordane. 9.3
48 ACDEN. alpha-Chlordene. 9.3
49 GCDEN. gamma-Chlordene. 9.3
50 CLPYR. Chlorpyrifos (Dursban). 8.2
51 DACTH. Dacthal. 9.3
52 OPDDD. o,p'-DDD. 8.2
53 PPDDD. p,p'-DDD. 9.3
54 OPDDE. o,p'-DDE. 8.2
55 PPDDE. p,p'-DDE. 8.2
56 PPDDMS. p,p'-DDMS. 8.2
57 PPDDMU. p,p'-DDMU. 8.2
58 OPDDT. o,p'-DDT. 8.2
59 PPDDT. p,p'-DDT. 8.2
60 DICLB. p,p'-Dichlorobenzophenone. 8.2
61 DIELDRIN. 9.3
62 ENDO_I. Endosulfan I. 9.3
63 ENDO_II. Endosulfan II. 8.2
64 ESO4. Endosulfan sulfate. 8.2
65 ENDRIN. 8.2
66 ETHION. 8.2
67 HCHA. alpha HCH 9.3
68 HCHB. beta HCH 8.2
69 HCHG. gamma HCH (Lindane) 9.3
70 HCHD. delta HCH 9.3
71 HEPTACHLOR. 9.3
72 HE. Heptachlor Epoxide. 9.3
73 HCB. Hexachlorobenzene. 9.3
74 METHOXY. Methoxychlor. 8.2
75 MIREX. 9.3
76 CNONA. cis-Nonachlor. 9.3
77 TNONA. trans-Nonachlor. 9.3
78 OXAD. Oxadiazon. 8.2
79 OCDAN. Oxychlordane. 9.3
80 TOXAPH. Toxaphene. 7.2
81 PESBATCH. The batch number that the sample was extracted in, character field width 11.
82 TBT. Tributyltin. 8.4
83 TBTBATCH. The batch number that the sample was extracted in, numeric field width 5 and 1 decimal places.
84 PCB5. 9.3
85 PCB8. 9.3
86 PCB15. 9.3
87 PCB18. 9.3
88 PCB27. 9.3
89 PCB28. 9.3

90 PCB29. 9.3
91 PCB31. 9.3
92 PCB44. 9.3
93 PCB49. 9.3
94 PCB52. 9.3
95 PCB66. 9.3
96 PCB70. 9.3
97 PCB74. 9.3
98 PCB87. 9.3
99 PCB95. 9.3
100 PCB97. 9.3
101 PCB99. 9.3
102 PCB101. 9.3
103 PCB105. 9.3
104 PCB110. 9.3
105 PCB118. 9.3
106 PCB128. 9.3
107 PCB132. 9.3
108 PCB137. 9.3
109 PCB138. 9.3
110 PCB149. 9.3
111 PCB151. 9.3
112 PCB153. 9.3
113 PCB156. 9.3
114 PCB157. 9.3
115 PCB158. 9.3
116 PCB170. 9.3
117 PCB174. 9.3
118 PCB177. 9.3
119 PCB180. 9.3
120 PCB183. 9.3
121 PCB187. 9.3
122 PCB189. 9.3
123 PCB194. 9.3
124 PCB195. 9.3
125 PCB201. 9.3
126 PCB203. 9.3
127 PCB206. 9.3
128 PCB209. 9.3
129 ARO1248. 9.3
130 ARO1254. 9.3
131 ARO1260. 9.3
132 ARO5460. 9.3
133 PCBBATCH. The batch number that the sample was extracted in, character field width 11.

134 ACY. Acenaphthylene. 8.2
135 ACE. Acenaphthene. 8.2
136 ANT. Anthracene. 8.2
137 BAA. Benz[a]anthracene. 8.2
138 BAP. Benzo[a]pyrene. 8.2
139 BBF. Benzo[b]fluoranthene. 8.2
140 BKF. Benzo[k]fluoranthene. 8.2
141 BGP. Benzo[ghi]perylene. 8.2
142 BEP. Benzo[e]pyrene. 8.2
143 BPH. Biphenyl. 8.2
144 CHR. Chrysene. 8.2
145 COR. Coronene. 8.2
146 DBA. Dibenz[a,h]anthracene. 8.2
147 DBT. Dibenzothiophene. 8.2
148 DMN. 2,6-Dimethylnaphthalene. 8.2
149 FLA. Fluoranthene. 8.2
150 FLU. Fluorene. 8.2
151 IND. Indeno[1,2,3-cd]pyrene. 8.2
152 MNP1. 1-Methylnaphthalene. 8.2
153 MNP2. 2-Methylnaphthalene. 8.2
154 MPH1. 1-Methylphenanthrene. 8.2
155 NPH. Naphthalene. 8.2
156 PHN. Phenanthrene. 8.2
157 PER. Perylene. 8.2
158 PYR. Pyrene. 8.2
159 TMN. 2,3,5-Trimethylnaphthalene. 8.2
160 TRY. Triphenylene 8.2
161 PAHBATCH. The batch number that the sample was extracted in, character field width 11.
162 SODATAQA. Data qualifier codes are notations used by data reviewers to briefly describe, or qualify data and the systems producing data, numeric field width 3. Data qualifier codes are as follows:

A. When the sample meets or exceeds the control criteria requirements, the value is reported as "-4".
B. When the sample has minor exceedences of control criteria but is generally usable for most assessments and reporting purposes, the value is reported as "-5". For samples coded "-5" it is recommended that if assessments are made that are especially sensitive or critical, the QA evaluations should be consulted before using the data.
C. When QA samples have major exceedences of control criteria requirements and the data are not usable for most assessments and reporting purposes, the value is reported as "-6".
D. When the sample has minor exceedences of control criteria and is unlikely to affect assessments, the value is reported as "-3".

SEDIMENT PARTICULATE SIZE ANALYSES DATA are presented in fields 163-166. The grain size results are reported as follows:

A. When the value is missing or not analyzed, the value is reported as "-9.0" = not analyzed.
B. When the value is less than the detection limit of the analytical test, the value is reported as "-8.0" = not detected.

163. FINES. Sediment grain size for each station, reported as percent fines. Numeric field, width 5 with 2 decimal places.
164. FINEBATCH. The batch number that the sample was analyzed in, character field,
165. width 6.
166. FINEDATAQC. Data qualifier codes are notations used by data reviewers to briefly describe, or qualify data and the systems producing data, numeric field, width 3. Data qualifier codes are as follows:

A. When the sample meets or exceeds the control criteria requirements, the value is reported as "-4".
B. When the sample has minor exceedences of control criteria but is generally usable for most assessments and reporting purposes, the value is reported as "-5". For samples coded "-5" it is recommended that if assessments are made that are especially sensitive or critical, QA evaluations should be consulted before using the data.
C. When QA samples have major exceedences of control criteria requirements and the data are not usable for most assessments and reporting purposes, the value is reported as "-6".
D. When the sample has minor exceedences of control criteria and is unlikely to affect assessments, the value is reported as "-3".

SEDIMENT TOTAL ORGANIC CARBON (TOC) ANALYSES DATA. Field 167-169 presents the levels of total organic carbon detected in the sediment samples at each station. All TOC results are reported as percent of dry weight.

167. TOC. Total Organic Carbon (TOC) levels (percent of dry weight) in sediment, for each station. Numeric field, width 6 and 2 decimal places.

A. When the value is missing or not analyzed, the value is reported as "-9.0" = not analyzed.
B. When the value is less than the detection limit of the analytical test, the value is reported as "-8.0" = not detected.

168. TOCBATCH. The batch number that the sample was analyzed in, numeric field width 4.
169. TOCDATAQC. Data qualifier codes are notations used by data reviewers to briefly describe, or qualify data and the systems producing data, numeric field width 3. Data qualifier codes are as follows:

A. When the sample meets or exceeds the control criteria requirements, the value is reported as "-4".
B. When the sample has minor exceedences of control criteria but is generally usable for most assessments and reporting purposes, the value is reported as "-5". For samples coded "-5" it is recommended that if assessments are made that are especially sensitive or critical, the QA evaluations should be consulted before using the data.
C. When QA samples have major exceedences of control criteria requirements and the data are not usable for most assessments and reporting purposes, the value is reported as "-6".

D. When the sample has minor exceedences of control criteria and is unlikely to affect assessments, the value is reported as "-3".

DISSOLVED ORGANIC CARBON (DOC) ANALYSES DATA. Field 170 presents the levels of dissolved organic carbon (µM) detected in water or porewater for each station.

170. DOC. Dissolved Organic Carbon (DOC) levels (µM) in water or porewater, for each station. Numeric field, width 6.

A. When the value is missing or not analyzed, the value is reported as "-9.0" = not analyzed.

B. When the value is less than the detection limit of the analytical test, the value is reported as "-8.0" = not detected.

The TOX1_56.DBF file is the toxicity data file which contains the following fields (the number at the start of each field is the field number):

1. STANUM. This numeric field is 7 characters wide with 1 decimal place and contains the CDFG station numbers that are used statewide. The format is YXXXX.Z where Y is the Regional Water Quality Control Board Region number and XXXX is the number that corresponds to a given location or site and Z is the number of the station within that site. An example is Southwest Slip in Los Angeles Harbor where the STANUM is 40001.1. The 4 indicates Region 4. The 0001 indicates that it is Site #1 and the .1 is the replicate station within Site #1. A site with a .0 designation indicates this is the only station at the site.
2. STATION. This character field is 30 characters wide and contains the exact name of the station.
3. IDORG. This numeric field is 8 characters wide and contains the unique i.d. organizational number for the sample. For each station collected on a unique date, an idorg sample number is assigned. This should be the field that links the collection, toxicity, chemical, and other databases.
4. DATE. This date field is 8 characters wide and is the date that each sample was collected in the field. It is listed as MM/DD/YY.
5. LEG. This numeric field is 6 characters wide and is the leg number of the project in which the sample was collected.
6. TYPE. This character field is 7 characters wide and describes whether the sample was a field sample, replicate or control.
7. METADATA. This is an index directing the user to tables or files of ancillary data pertinent to associated test. Character field, width 12.
8. CTRL. This character field is 5 characters wide and indicates the type of control sample used for the test.
9. LATITUDE. This character field is 12 characters wide and contains the latitude of the center of the station sampled. The format is a character field as follows: XX,YY,ZZ, where XX is in degrees, YY is in minutes, and ZZ is in seconds or hundreds.
10. LONGITUDE. This character field is 14 characters wide and contains the longitude of the center of the station sampled. The format is a character field as follows:

XXX,YY,ZZ, where XXX is in degrees, YY is in minutes, and ZZ is in seconds or hundreds.

11. HUND_SECS. This character is 3 character wide and contains the designation "h" if the latitude and longitude are given in degrees, minutes, hundredths of a minute. The designation "h/d" is given if differential accuracy is achieved with the GPS unit. The designation "s" is given when latitude and longitude are given in degrees, minutes, seconds.
12. GISLAT. This numeric field is 12 characters wide with 8 decimal places and contains the latitude of the station sampled in Geographical Information System format. The format is a numeric field as follows: XX.YYYYYYYY, where XX is in degrees and YYYYYYYY is a decimal fraction of the preceding degree.
13. GISLONG. This numeric field is 14 characters wide with 8 decimal places and contains the longitude of the station sampled. The format is a character field as follows: XXXX.YYYYYYYY where XXXX is in degrees and YYYYYYYY is a decimal fraction of the preceding degree.

AMPHIPOD SURVIVAL TOXICITY TEST DATA. The following are descriptions of the field headings for the amphipod *Eohaustorius estuarius* (EE) toxicity test using homogenized sediment samples; presented in fields 14 through 25.

14. EE_MN. Station mean percent survival. Numeric field, width 6 and 2 decimal places.
15. EE_SD. Station standard deviation of percent survival. Numeric field, width 6 and 2 decimal places.
16. EE_SG. Station statistical significance, representing the significance of the statistical test between the home sediment and the sample. A single * represents significance at the .05 level, and double ** represents significance at the .01 level. ns = not statistically significant. Character field, width 5.
17. EE_TOX. Sample is considered toxic and denoted with a "T" if: 1) Sample mean is significantly different from control mean when compared using a t-test ($p = 0.05$). 2) If sample mean as a percent of the control mean is less than 75% of the control (MSD as a percent of the control). "NT" signifies non-toxic. Character field, width 3.
18. EE_BATCH. The batch number that the sample were run in, character width 10.
19. EEQC. Data qualifier codes are notations used by data reviewers to briefly describe, or qualify data and the systems producing data, numeric width 4. Data qualifier codes are as follows:
    A. When the sample meets or exceeds the control criteria requirements, the value is reported as "-4".
    B. When the sample has minor exceedences of control criteria but is generally usable for most assessments and reporting purposes, the value is reported as "-5". For samples coded "-5" it is recommended that if assessments are made that are especially sensitive or critical, the QA evaluations should be consulted before using the data.
    C. When the QA sample has major exceedences of control criteria requirements and the data are not usable for most assessments and reporting purposes, the value is reported as "-6".
    D. When the sample has minor exceedences of control criteria and is unlikely to affect assessments, the value is reported as "-3".

20. EE_OTNH3. Total ammonia concentration (ppm in water) in overlying water (water above bedded sediment) for each station analyzed using amphipod toxicity tests. When the value is missing or not analyzed, the value is reported as "-9.0" = not analyzed. When the value is less than the detection limit of the analytical test, the value is reported as "-8.0" = not detected. Numeric field, width 7 and 3 decimal places.

21. EE_OUNH3. Unionized ammonia concentration (ppm in water) in overlying water (water above bedded sediment) for each station analyzed using amphipod toxicity tests. When the value is missing or not analyzed, the value is reported as "-9.0" = not analyzed. When the value is less than the detection limit of the analytical test, the value is reported as "-8.0" = not detected. Numeric field, width 7 and 3 decimal places.

22. EE_OH2S. Hydrogen sulfide concentration (ppm in water) in overlying water (water above bedded sediment) for each station analyzed using amphipod toxicity tests. When the value is missing or not analyzed, the value is reported as "-9.0" = not analyzed. When the value is less than the detection limit of the analytical test, the value is reported as "-8.0" = not detected. Numeric field, width 7 and 4 decimal places.

23. EE_ITNH3. Total ammonia concentration (ppm in water) in interstitial water (water within bedded sediment) for each station analyzed using amphipod toxicity tests. When the value is missing or not analyzed, the value is reported as "-9.0" = not analyzed. When the value is less than the detection limit of the analytical test, the value is reported as "-8.0" = not detected. Numeric field, width 7 and 3 decimal places.

24. EE_IUNH3. Unionized ammonia concentration (ppm in water) interstitial water (water within bedded sediment) for each station analyzed using amphipod toxicity tests. When the value is missing or not analyzed, the value is reported as "-9.0" = not analyzed. When the value is less than the detection limit of the analytical test, the value is reported as "-8.0" = not detected. Numeric field, width 7 and 3 decimal places.

25. EE_IH2S. Hydrogen sulfide concentration (ppm in water) in interstitial water (water within bedded sediment) for each station analyzed using amphipod toxicity tests. When the value is missing or not analyzed, the value is reported as "-9.0" = not analyzed. When the value is less than the detection limit of the analytical test, the value is reported as "-8.0" = not detected. Numeric field, width 7 and 4 decimal places.

The following are descriptions of the field headings for the sea urchin (*Strongylocentrotus purpuratus*) development toxicity tests (SPDI), using the sediment/water interface exposure to intact sediment cores; presented in fields 26 through 34.

26. SPDI_MN. Station mean percent normal development in the sediment/water interface exposure. Numeric field, width 6 and 2 decimal places.

27. SPDI_SD. Station standard deviation of percent normal development in the sediment/water interface exposure. Numeric field, width 6 and 2 decimal places.

28. SPDI_SG. Station statistical significance, representing the significance of the statistical test between the home sediment and the sample. A single * represents significance at the .05 level, and double ** represents significance at the .01 level. ns = not statistically significant. Character field, width 5.

29. SPDI_TOX. Sample is considered toxic and denoted with a "T" if: 1) Sample mean is significantly different from control mean when compared using a t-test (p= 0.05). 2) If

sample mean as a percent of the control mean is less than 59% of the control (MSD as a percent of the control). "NT" signifies non-toxic. Character field, width 3.

30. SPDI_BATCH. The batch number that the samples were analyzed in, character field width 10.

31. SPDIQC. Data qualifier codes are notations used by data reviewers to briefly describe, or qualify data and the systems producing data, numeric field width 4. Data qualifier codes are as follows:

   A. When the sample meets or exceeds the control criteria requirements, the value is reported as "-4".

   B. When the sample has minor exceedences of control criteria but is generally usable for most assessments and reporting purposes, the value is reported as "-5". For samples coded "-5" it is recommended that if assessments are made that are especially sensitive or critical, the QA evaluations should be consulted before using the data.

   C. When the QA sample has major exceedences of control criteria requirements and the data are not usable for most assessments and reporting purposes, the value is reported as "-6".

   D. When the sample has minor exceedences of control criteria and is unlikely to affect assessments, the value is reported as "-3".

32. SPDI_OTNH3. Total ammonia concentration (ppm in water) in overlying water samples (water above bedded sediment used for urchin toxicity tests). When the value is missing or not analyzed, the value is reported as "-9.0" = not analyzed. When the value is less than the detection limit of the analytical test, the value is reported as "-8.0" = not detected. Numeric field, width 7 and 3 decimal places.

33. SPDI_OUNH3. Unionized ammonia concentration (ppm in water) in overlying water samples (water above bedded sediment) for each station analyzed using urchin toxicity tests. When the value is missing or not analyzed, the value is reported as "-9.0" = not analyzed. When the value is less than the detection limit of the analytical test, the value is reported as "-8.0" = not detected. Numeric field, width 7 and 3 decimal places.

34. SPDI_OH2S. Hydrogen sulfide concentration (ppm in water) in overlying water (water above bedded sediment) for each station analyzed using urchin toxicity tests. When the value is missing or not analyzed, the value is reported as "-9.0" = not analyzed. When the value is less than the detection limit of the analytical test, the value is reported as "-8.0" = not detected. Numeric field, width 7 and 4 decimal places.

The TISS1_56.DBF file contains the same fields as CHEM1_56.DBF file with the exception of the Trace Metal fields, and the addition of the following fields (the number at the start of each field is the field number):

1. TISS_TYPE. This character field is 25 characters wide and describes what type of tissue was analyzed.

2. NO_IN_COMP. The number of fish in each composite making up each sample. Numeric field, width 5.

The BEN1_56.XLS file contains the following fields (the number at the start of each field is the field number):

1. STANUM. This field contains the CDFG station numbers that are used statewide. The format is YXXXX.Z where Y is the Regional Water Quality Control Board Region number and XXXX is the number that corresponds to a given location or site and Z is the number of the station within that site. An example is San Pablo Bay- Island #1, in San Francisco Bay, where the STANUM is 20007.0. The 2 indicates Region 2. The 0007 indicates it is Site 7 and the .0 is the replicate (if any) at the station within Site 7.
2. STATION. This field contains the exact name of the station.
3. IDORG. This field contains the unique i.d. organizational number for the sample. For each station collected on a unique date, an idorg sample number is assigned. This should be the field that links the collection, toxicity, chemical, and other databases.
4. DATE. This field is the date that each sample was collected in the field. It is listed as MM/DD/YY.
5. LEG. This field is the leg number of the project in which the sample was collected.
6. SPECIES. This field contains the different organisms found at a station, genus is given, and species if available.
7. TOTAL INDIVIDUALS. This field contains the total number of individuals found at a station.
8. TOTAL SPECIES. This field contains the total number of species found at a station.
9. TOTAL CRUST. INDIV. This field contains the total number of individuals in the Subphylum Crustacea found at a station.
10. TOTAL CRUST. SP. This field contains the total number of species in the Subphylum Crustacea found at a station.
    - A. GAMMARID INDIV. This field contains the number of individuals in the Suborder Gammaridea found at a station.
    - B. GAMMARID SP. This field contains the number of species in the Suborder Gammaridea found at a station.
    - C. OTHER CRUSTACEAN INDIV. This field contains the number of individuals, other than in the Suborder Gammaridea, in the Subphylum Crustacea, found at a station.
    - D. OTHER CRUSTACEAN SP. This field contains the number of species, other than in the Suborder Gammaridea, in the Subphylum Crustacea, found at a station.
15. TOTAL ECHINODERM INDIV. This field contains the number of individuals in the Phylum Echinodermata found at a station.
16. TOTAL ECHINODERM SP. This field contains the number of species in the Phylum Echinodermata found at a station.
17. TOTAL MOLLUSC INDIV. This field contains the number of individuals in the Phylum Mollusca found at a station.
18. TOTAL MOLLUSC SP. This field contains the number of species in the Phylum Mollusca found at a station.
19. TOTAL POLYCHAETE INDIV. This field contains the number of individuals in the Class Polychaeta found at a station.
20. TOTAL POLYCHAETE SP. This field contains the number of species in the Class Polychaeta found at a station.
21. TAXA. This field contains the different taxa found at a station.

22. # OF SPECIES. This field contains number of species found at a station.

23. NUMBER PER CORE. Number of individuals/species found in a numbered replicate core.

24. SUMMARY STATISTICS. This field contains a summary of statistical analyses. This field refers to fields 6-23.

    A. MEAN. Mean value of individuals/species in all cores analyzed.

    B. MEDIAN. Median of individuals/species in all cores analyzed.

    C. MIN. Minimum number of individuals/species found in any core.

    D. MAX. Maximum number of individuals/species found in any core.

    E. ST. DEV. Standard deviation of the above mean value.

    F. S.E. Standard error of the above mean value.

    G. 95%CL. 95% Confidence limit.

36. H. SUM. This field contains the sum of individuals/species found in all cores analyzed

APPENDIX B

Sampling Data

BPTCP SAMPLING DATES, LOCATIONS, DEPTH (m), SALINITY (ppt), AND SEDIMENT TEXTURES

STANUM	STATION	DATE	IDORG	LEG	LATITUDE	LONGITUDE	HUND_SECS	GISLAT	GISLONG
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	12/3/96	1673	47.0	32,40,854N	117,07,741W	h	32.68090000	117.12901670
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	12/3/96	1674	47.0	32,40,531N	117,07,476W	h	32.67551670	117.12460000
90022.0	P SWARTZ (NAVAL BASE O12)	12/3/96	1675	47.0	32,40,712N	117,07,463W	h	32.67853330	117.12438330
90039.0	CL	12/3/96	1676	47.0	32,42,117N	117,09,518W	h	32.70195000	117.15863330
93179.0	NAVAL SHIPYARDS O3 (x1)	12/3/96	1677	47.0	32,41,623N	117,08,917W	h	32.69371670	117.14861670
90020.0	G DE LAPPE	12/3/96	1678	47.0	32,41,594N	117,08,854W	h	32.69323330	117.14756670
93178.0	NAVAL SHIPYARDS O2 (x1)	12/3/96	1679	47.0	32,41,719N	117,08,998W	h	32.69531670	117.14996670
90013.0	37 SWARTZ (MARINA)	12/3/96	1680	47.0	32,39,150N	117,08,871W	h	32.65250000	117.14785000
95006.0	LOS PENASQUITOS (319)	12/4/96	1681	47.0	32,55,914N	117,15,178W	h	32.93190000	117.25296670

*Area stations have been subdivided into : C = Commercial Basin, B = Small Boats, N = Navy, R = River/Estuary

BPTCP SAMPLING DATES, LOCATIONS, DEPTH (m), SALINITY (ppt), AND SEDIMENT TEXTURES

STANUM	STATION	DATE	IDORG	LEG	AREA	DEPTH	TEMP_C	SALINITY	SED_TEXTUR
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	12/3/96	1673	47.0	N	9	17.0	33	SMOOTH, CREAMY
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	12/3/96	1674	47.0	N	11	17.0	33	FINE MUD
90022.0	P SWARTZ (NAVAL BASE O12)	12/3/96	1675	47.0	N	9	17.0	32	CREAMY
90039.0	CL	12/3/96	1676	47.0	C	8	17.0	34	GRIT, LEAF LITTER ,ORGANICS
93179.0	NAVAL SHIPYARDS O3 (x1)	12/3/96	1677	47.0	N	5	17.0	33	SMOOTH, CREAMY
90020.0	G DE LAPPE	12/3/96	1678	47.0	C	8	17.0	33	CREAMY, SMOOTH
93178.0	NAVAL SHIPYARDS O2 (x1)	12/3/96	1679	47.0	N	3	17.0	34	CLUMPY
90013.0	37 SWARTZ (MARINA)	12/3/96	1680	47.0	B	3	16.0	35	CREAMY
95006.0	LOS PENASQUITOS (3 19)	12/4/96	1681	47.0	R	1	24.0	25	CREAMY W/ANOXIC LAYER

*Area stations have been subdivided into : C = Commercial Basin, B = Small Boats, N = Navy, R = River/Estuary

APPENDIX C

Analytical Chemistry Data

SECTION I

Trace Metal Analysis of Sediments

TRACE METAL ANALYSIS OF SEDIMENTS (dry weight-ppm-ng/g)

STANUM	STATION	IDORG	DATE	LEG	METADATA	TMMOIST	ALUMINUM	ANTIMONY	ARSENIC	CADMIUM	CHROMIUM
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	CHM47_56.TXT	59.60	99600.00	2.530	-9.000	0.4460	86.800
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	CHM47_56.TXT	59.00	39100.00	1.800	-9.000	0.3960	73.300
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	CHM47_56.TXT	68.70	93700.00	4.280	-9.000	1.0600	91.700
90039.0	CL	1676	12/3/96	47.0	CHM47_56.TXT	47.50	74700.00	1.600	-9.000	0.8480	27.400
93179.0	NAVAL SHIPYARDS O3 (x1)	1677	12/3/96	47.0	CHM47_56.TXT	67.00	135000.00	39.100	-9.000	0.9650	111.000
90020.0	G DE LAPPE	1678	12/3/96	47.0	CHM47_56.TXT	70.00	121000.00	7.820	-9.000	0.5530	102.000
93178.0	NAVAL SHIPYARDS O2 (x1)	1679	12/3/96	47.0	CHM47_56.TXT	51.50	97600.00	6.440	-9.000	2.5300	74.700
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	CHM47_56.TXT	64.60	109000.00	2.000	-9.000	0.2450	82.700
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47.0	CHM47_56.TXT	-9.00	-9.00	-9.000	-9.000	-9.0000	-9.000

TRACE METAL ANALYSIS OF SEDIMENTS (dry weight-ppm-ng/g)

STANUM	STATION	IDORG	DATE	LEG	COPPER	IRON	LEAD	MANGANESE	MERCURY	NICKEL	SILVER	SELENIUM	TIN
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	207.00	45000.0	46.400	434.00	0.6000	21.100	1.6400	-9.000	6.9300
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	261.00	49500.0	37.300	531.00	0.5200	26.800	1.1800	-9.000	5.7000
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	333.00	49600.0	58.100	498.00	0.9900	26.700	2.7200	-9.000	8.1700
90039.0	CL	1676	12/3/96	47.0	58.40	22000.0	204.000	328.00	0.1150	11.400	0.2180	-9.000	3.7800
93179.0	NAVAL SHIPYARDS O3 (x1)	1677	12/3/96	47.0	369.00	56900.0	152.000	595.00	0.8310	26.500	1.3600	-9.000	9.5800
90020.0	G DE LAPPE	1678	12/3/96	47.0	296.00	54100.0	88.500	482.00	1.1700	30.000	1.4500	-9.000	10.7000
93178.0	NAVAL SHIPYARDS O2 (x1)	1679	12/3/96	47.0	244.00	36800.0	127.000	441.00	0.9150	22.000	1.2400	-9.000	9.9600
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	135.00	59900.0	25.800	635.00	0.4420	23.400	1.1600	-9.000	5.9900
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47.0	-9.00	-9.0	-9.000	-9.00	-9.0000	-9.000	-9.0000	-9.000	-9.0000

TRACE METAL ANALYSIS OF SEDIMENTS (dry weight-ppm-ug/g)

STANUM	STATION	IDORG	DATE	LEG	ZINC	ASBATCH	SEBATCH	TMBATCH	TMDATAQC
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	308.0000	-9.00	-9.00	97.30	-4
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	321.0000	-9.00	-9.00	97.30	-4
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	432.0000	-9.00	-9.00	97.30	-4
90039.0	CL	1676	12/3/96	47.0	307.0000	-9.00	-9.00	97.30	-4
93179.0	NAVAL SHIPYARDS O3 (x1)	1677	12/3/96	47.0	1190.0000	-9.00	-9.00	97.30	-4
90020.0	G DE LAPPE	1678	12/3/96	47.0	542.0000	-9.00	-9.00	97.30	-4
93178.0	NAVAL SHIPYARDS O2 (x1)	1679	12/3/96	47.0	749.0000	-9.00	-9.00	97.30	-4
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	325.0000	-9.00	-9.00	97.30	-4
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47.0	-9.0000	-9.00	-9.00	-9.00	-9

SECTION II

AVS/SEM

AVS/SEM ANALYSIS (dry weight-ppm-ug/g)

STANUM	STATION	IDORG	DATE	LEG	METADATA	AVS	SEM_CD	SEM_CU	SEM_NI	SEM_PB	SEM_ZN	SEM_SUM
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	CHM47_56.TXT	12.5000	0.00548	1.0100	0.0724	0.3040	2.9800	4.3700
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	CHM47_56.TXT	5.4400	0.00448	1.1400	0.0923	0.2480	2.4600	3.9400
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	CHM47_56.TXT	9.1500	0.01020	1.9400	0.0777	0.3550	3.6900	6.0700
90039.0	CL	1676	12/3/96	47.0	CHM47_56.TXT	76.8000	0.01080	0.2270	0.1160	0.5740	3.4900	4.4200
93179.0	NAVAL SHIPYARDS O3 (x1)	1677	12/3/96	47.0	CHM47_56.TXT	22.3000	0.01480	1.2800	0.0835	0.6180	10.8000	12.8000
90020.0	G DE LAPPE	1678	12/3/96	47.0	CHM47_56.TXT	8.4000	0.00475	1.7000	0.0785	0.4830	4.2800	6.5500
93178.0	NAVAL SHIPYARDS O2 (x1)	1679	12/3/96	47.0	CHM47_56.TXT	11.8000	0.02050	1.0100	0.0550	0.5160	7.0700	8.6700
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	CHM47_56.TXT	15.6000	0.00249	0.7380	0.0595	0.4810	2.9200	4.2000
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47.0	CHM47_56.TXT	-9.0000	-9.00000	-9.0000	-9.0000	-9.0000	-9.0000	-9.0000

AVS/SEM ANALYSIS (dry weight-ppm-ug/g)

STANUM	STATION	IDORG	DATE	LEG	SEM_AVS	AVS_BATCH	AVSDATAQC
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	0.3500	22.10	-3
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	0.7240	22.10	-3
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	0.6630	22.20	-3
90039.0	CL	1676	12/3/96	47.0	0.0576	22.20	-3
93179.0	NAVAL SHIPYARDS O3 (x1)	1677	12/3/96	47.0	0.5740	22.20	-3
90020.0	G DE LAPPE	1678	12/3/96	47.0	0.7800	22.30	-3
93178.0	NAVAL SHIPYARDS O2 (x1)	1679	12/3/96	47.0	0.7350	22.30	-3
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	0.2690	22.40	-3
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47.0	-9.0000	-9.00	-9

SECTION III

Pesticide Analysis of Sediments

PCB CONGENER AND AROCLOR ANALYSIS OF SEDIMENTS (dry weight-ppb-ng/g)

STANUM	STATION	IDORG	DATE	LEG	PCB203	PCB206	PCB209	ARO1248	ARO1254	ARO1260	ARO5460	PCBBATCH
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	3.140	5.290	9.580	-8.000	284.000	-8.000	-9.000	97-325
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	1.600	2.320	4.580	-8.000	137.000	-8.000	-9.000	97-325
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	3.330	6.640	11.500	-8.000	354.000	-8.000	-9.000	97-325
90039.0	CL	1676	12/3/96	47.0	2.890	0.785	4.000	-8.000	190.000	-8.000	-9.000	97-325
93179.0	NAVAL SHIPYARDS O3 (x1)	1677	12/3/96	47.0	13.100	34.000	14.200	-8.000	1510.000	-8.000	-9.000	97-329
90020.0	G DE LAPPE	1678	12/3/96	47.0	9.320	9.160	5.150	-8.000	3250.000	-8.000	-9.000	97-329
93178.0	NAVAL SHIPYARDS O2 (x1)	1679	12/3/96	47.0	11.950	7.120	5.741	-8.000	1880.940	-8.000	-9.000	97-329
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	-8.000	0.716	1.620	-8.000	77.700	-8.000	-9.000	97-329
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47.0	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000	-9

SECTION V

PAH Analysis of Sediments

PAH ANALYSIS OF SEDIMENTS (dry weight-ppb-ng/g)

STANUM	STATION	IDORG	DATE	LEG	ACY	ACE	ANT	BAA	BAP	BBF	BKF	BGP	BEP	BPH	CHR
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	395.00	10.40	953.00	963.00	826.00	2050.00	1660.00	640.00	1370.00	10.30	2300.00
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	396.00	38.10	949.00	720.00	1160.00	1880.00	1450.00	579.00	1220.00	37.90	1560.00
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	630.00	48.20	1570.00	1400.00	2220.00	3430.00	2660.00	1030.00	2170.00	47.90	2810.00
90039.0	CL	1676	12/3/96	47.0	123.00	252.00	473.00	1020.00	946.00	1130.00	1110.00	991.00	962.00	251.00	1680.00
93179.0	NAVAL SHIPYARDS O3 (x1)	1677	12/3/96	47.0	513.00	73.90	1460.00	2690.00	3700.00	4650.00	3360.00	1500.00	2570.00	74.00	4680.00
90020.0	G DE LAPPE	1678	12/3/96	47.0	375.00	33.70	759.00	2050.00	1990.00	3200.00	2550.00	1180.00	1620.00	33.70	3430.00
93178.0	NAVAL SHIPYARDS O2 (x1)	1679	12/3/96	47.0	195.00	32.60	516.00	634.00	1700.00	2310.00	1630.00	880.00	1500.00	32.60	1290.00
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	5.83	-8.00	6.33	17.40	27.00	43.00	41.70	51.10	37.00	-8.00	32.80
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47.0	-9.00	-9.00	-9.00	-9.00	-9.00	-9.00	-9.00	-9.00	-9.00	-9.00	-9.00

PAH ANALYSIS OF SEDIMENTS (dry weight-ppb-ng/g)

STANUM	STATION	IDORG	DATE	LEG	COR	DBA	DBT	DMN	FLA	FLU	IND	MNP1	MNP2	MPH1	NPH	PHN
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	50.00	225.00	21.30	8.73	1710.00	62.20	867.00	4.28	13.30	49.00	21.40	516.00
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	47.70	209.00	15.50	8.80	1080.00	61.10	795.00	12.60	12.80	38.00	18.80	370.00
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	74.70	387.00	44.00	14.30	2540.00	104.00	1440.00	8.57	15.50	77.30	47.20	818.00
90039.0	CL	1676	12/3/96	47.0	181.00	176.00	187.00	54.40	4680.00	203.00	964.00	99.10	135.00	246.00	191.00	3990.00
93179.0	NAVAL SHIPYARDS O3 (x1)	1677	12/3/96	47.0	159.00	536.00	118.00	12.20	6790.00	171.00	2170.00	25.20	49.10	167.00	81.00	1540.00
90020.0	G DE LAPPE	1678	12/3/96	47.0	115.00	422.00	29.40	12.70	3410.00	68.70	1680.00	16.30	28.40	64.30	59.30	479.00
93178.0	NAVAL SHIPYARDS O2 (x1)	1679	12/3/96	47.0	88.20	305.00	31.80	19.90	1160.00	50.10	1240.00	18.30	36.50	64.50	58.30	417.00
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	12.50	7.42	-8.00	-8.00	52.00	-8.00	51.50	-8.00	-8.00	-8.00	9.80	12.10
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47.0	-9.00	-9.00	-9.00	-9.00	-9.00	-9.00	-9.00	-9.00	-9.00	-9.00	-9.00	-9.00

PAH ANALYSIS OF SEDIMENTS (dry weight-ppb-ng/g)

STANUM	STATION	IDORG	DATE	LEG	PER	PYR	TMN	TRY	PAHBATCH	SODATAQA
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	323.00	1670.00	5.60	-9.00	97-325	-5
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	351.00	1630.00	2.55	-9.00	97-325	-5
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	670.00	3340.00	7.09	-9.00	97-325	-5
90039.0	CL	1676	12/3/96	47.0	295.00	4380.00	23.50	-9.00	97-325	-5
93179.0	NAVAL SHIPYARDS O3 (x1)	1677	12/3/96	47.0	971.00	5660.00	7.43	-9.00	97-329	-5
90020.0	G DE LAPPE	1678	12/3/96	47.0	618.00	3670.00	4.77	-9.00	97-329	-5
93178.0	NAVAL SHIPYARDS O2 (x1)	1679	12/3/96	47.0	472.00	2240.00	5.86	-9.00	97-329	-5
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	6.23	64.30	-8.00	-9.00	97-329	-5
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47.0	-9.00	-9.00	-9.00	-9.00	-9	-9

SECTION VI

Sediment Chemistry Summations and Quotients

SEDIMENT CHEMISTRY SUMMATIONS AND QUOTIENTS

STANUM	STATION	IDORG	DATE	LEG	TTL CHLR	TTL DDT	TTL PCB	LMW PAH	HMW PAH	TTL PAH	ERMQ	PELQ	ERMEXCDS	PELEXCDS
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47	5.780	19.70	340.072	2049.21	14604.00	16653.21	0.585	0.944	2	15
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47	5.760	41.02	166.450	1945.65	12634.00	14579.65	0.489	0.835	1	13
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47	8.020	27.63	419.640	3388.06	24097.00	27485.06	0.855	1.398	12	19
90039.0	CL	1676	12/3/96	47	133.350	109.28	229.170	6041.00	18334.00	24375.00	2.142	3.785	7	20
93179.0	NAVAL SHIPYARDS O3 (x1)	1677	12/3/96	47	11.050	31.09	1240.340	4173.83	39277.00	43450.83	1.545	2.227	16	20
90020.0	G DE LAPPE	1678	12/3/96	47	18.410	41.82	2649.020	1934.87	25820.00	27754.87	1.840	2.463	11	17
93178.0	NAVAL SHIPYARDS O2 (x1)	1679	12/3/96	47	15.523	32.59	1735.754	1446.66	15361.00	16807.66	1.372	1.875	7	16
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47	1.165	4.28	74.708	54.06	431.45	485.51	0.232	0.407	0	2
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47	-9.000	-9.00	-9.000	-9.00	-9.00	-9.00	-9.000	-9.000	0	0

SECTION VII

Pesticide Analysis of Tissue

PESTICIDE ANALYSIS OF TISSUE (wet weight-ppb-ng/g)

STANUM	STATION	IDORG	DATE	LEG	TISS_TYPE	NO_IN_COMP	SOWEIGHT	SOMOIST	SOLIPID	ALDRIN	CCHLOR
90057.0	SILVERGATE (5 SDG&E)	286.0	10/6/92	-9.0	FISH- TOPSMELT	15	2.62	77.12	1.00	-8.000	0.057
90057.0	SILVERGATE (5 SDG&E)	287.0	10/6/92	-9.0	FISH- ROUND STINGRAY	15	2.66	75.00	0.88	-8.000	-8.000

PESTICIDE ANALYSIS OF TISSUE (wet weight-ppb-ng/g)

STANUM	STATION	IDORG	TISS_TYPE	TCHLOR	ACDEN	GCDEN	TTL_CHLR	CLPYR	DACTH	OPDDD	PPDDD	OPDDE	PPDDE
90057.0	SILVERGATE (5 SDG&E)	286.0	FISH- TOPSMELT	0.046	-8.000	-8.000	0.609	-8.00	-8.000	0.21	0.164	-8.00	1.97
90057.0	SILVERGATE (5 SDG&E)	287.0	FISH- ROUND STINGRAY	-8.000	-8.000	-8.000	0.444	-8.00	-8.000	0.09	-8.000	-8.00	-8.00

PESTICIDE ANALYSIS OF TISSUE (wet weight-ppb-ng/g)

STANUM	STATION	IDORG	TISS_TYPE	PPDDMS	PPDDMU	OPDDT	PPDDT	TTL_DDT	DICLB	DIELDRIN	ENDO_I	ENDO_II	ESO4
90057.0	SILVERGATE (5 SDG&E)	286.0	FISH- TOPSMELT	-8.00	-8.00	-8.00	-8.00	3.44	-8.00	-8.000	-8.000	-8.00	-8.00
90057.0	SILVERGATE (5 SDG&E)	287.0	FISH- ROUND STINGRAY	-8.00	-8.00	-8.00	-8.00	1.59	-8.00	-8.000	-8.000	-8.00	-8.00

PESTICIDE ANALYSIS OF TISSUE (wet weight-ppb-ng/g)

STANUM	STATION	IDORG	TISS_TYPE	ENDRIN	HCHA	HCHB	HCHG	HCHD	HEPTACHLOR	HE	HCB	METHOXY	MIREX
90057.0	SILVERGATE (5 SDG&E)	286.0	FISH- TOPSMELT	-8.00	-8.000	-8.00	-8.000	-8.000	-8.000	-8.000	-8.000	-8.00	-8.000
90057.0	SILVERGATE (5 SDG&E)	287.0	FISH- ROUND STINGRAY	-8.00	-8.000	-8.00	-8.000	-8.000	-8.000	-8.000	-8.000	-8.00	-8.000

PESTICIDE ANALYSIS OF TISSUE (wet weight-ppb-ng/g)

STANUM	STATION	IDORG	TISS_TYPE	CNONA	TNONA	OXAD	OCDAN	TOXAPH	PESBATCH
90057.0	SILVERGATE (5 SDG&E)	286.0	FISH- TOPSMELT	0.177	0.261	-9.00	0.068	-8.00	73.70
90057.0	SILVERGATE (5 SDG&E)	287.0	FISH- ROUND STINGRAY	0.070	0.074	-9.00	-8.000	-8.00	73.70

SECTION VIII

PCB and Aroclor Analysis of Tissue

PCB CONGENER AND AROCLOR ANALYSIS OF TISSUE (wet weight-ppb-ng/g)

STANUM	STATION	IDORG	DATE	LEG	TISS_TYPE	NO_IN_COMP	PCB5	PCB8	PCB15	PCB18	PCB27	PCB28	PCB29	PCB31	PCB44
90057.0	SILVERGATE (5 SDG&E)	286.0	10/6/92	-9.0	FISH- TOPSMELT	15	-9.000	-8.000	-9.000	-8.000	-9.000	-8.000	-9.000	-9.000	-8.000
90057.0	SILVERGATE (5 SDG&E)	287.0	10/6/92	-9.0	FISH- ROUND STINGRAY	15	-9.000	-8.000	-9.000	-8.000	-9.000	-8.000	-9.000	-9.000	-8.000

PCB CONGENER AND AROCLOR ANALYSIS OF TISSUE (wet weight-ppb-ng/g)

STANUM	STATION	IDORG	TISS_TYPE	PCB49	PCB52	PCB66	PCB70	PCB74	PCB87	PCB95	PCB97	PCB99	PCB101	PCB105	PCB110
90057.0	SILVERGATE (5 SDG&E)	286.0	FISH- TOPSMELT	-9.000	0.436	0.311	-9.000	-9.000	0.075	-9.000	-9.000	-9.000	1.110	-8.000	-9.000
90057.0	SILVERGATE (5 SDG&E)	287.0	FISH- ROUND STINGRAY	-9.000	-8.000	0.067	-9.000	-9.000	-8.000	-9.000	-9.000	-9.000	-8.000	-8.000	-9.000

PCB CONGENER AND AROCLOR ANALYSIS OF TISSUE (wet weight-ppb-ng/g)

STANUM	STATION	IDORG	TISS_TYPE	PCB118	PCB128	PCB132	PCB137	PCB138	PCB149	PCB151	PCB153	PCB156	PCB157	PCB158
90057.0	SILVERGATE (5 SDG&E)	286.0	FISH- TOPSMELT	1.150	0.254	-9.000	-9.000	2.530	-9.000	-9.000	3.870	-9.000	-9.000	-9.000
90057.0	SILVERGATE (5 SDG&E)	287.0	FISH- ROUND STINGRAY	0.685	0.191	-9.000	-9.000	1.210	-9.000	-9.000	4.010	-9.000	-9.000	-9.000

PCB CONGENER AND AROCLOR ANALYSIS OF TISSUE (wet weight-ppb-ng/g)

STANUM	STATION	IDORG	TISS_TYPE	PCB170	PCB174	PCB177	PCB180	PCB183	PCB187	PCB189	PCB194	PCB195	PCB201	PCB203
90057.0	SILVERGATE (5 SDG&E)	286.0	FISH- TOPSMELT	0.231	-9.000	-9.000	1.270	-9.000	1.060	-9.000	-9.000	-8.000	-9.000	-9.000
90057.0	SILVERGATE (5 SDG&E)	287.0	FISH- ROUND STINGRAY	0.443	-9.000	-9.000	2.290	-9.000	0.380	-9.000	-9.000	-8.000	-9.000	-9.000

PCB CONGENER AND AROCLOR ANALYSIS OF TISSUE (wet weight-ppb-ng/g)

STANUM	STATION	IDORG	TISS_TYPE	PCB206	PCB209	CBBATC	ARO5460	ARO1248	ARO1254	ARO1260	TTL_PCB
90057.0	SILVERGATE (5 SDG&E)	286.0	FISH- TOPSMELT	0.049	-8.000	73.70	-9.000	-9.000	-9.000	-9.000	25.942
90057.0	SILVERGATE (5 SDG&E)	287.0	FISH- ROUND STINGRAY	0.048	-8.000	73.70	-9.000	-9.000	-9.000	-9.000	20.448

SECTION IX

PAH Analysis of Tissue

PAH ANALYSIS OF TISSUE (wet weight-ppb-ng/g)

STANUM	STATION	IDORG	DATE	LEG	TISS_TYPE	NO_IN_COMP	ACY	ACE	ANT	BAA	BAP	BBF	BKF	BGP	BEP	BPH	CHR	COR	DBA
90057.0	SILVERGATE (5 SDG&E)	286.0	10/6/92	-9.0	FISH- TOPSMELT	15	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-9.00	-8.00
90057.0	SILVERGATE (5 SDG&E)	287.0	10/6/92	-9.0	FISH- ROUND STINGRAY	15	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-9.00	-8.00

PAH ANALYSIS OF TISSUE (wet weight-ppb-ng/g)

STANUM	STATION	IDORG	TISS_TYPE	DBT	DMN	FLA	FLU	IND	MNP1	MNP2	MPH1	NPH	PHN	PER	PYR	TMN	TRY	PAHBATCH	SODATAQA
90057.0	SILVERGATE (5 SDG&E)	286.0	FISH- TOPSMELT	-9.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-9.00	73.70	-5
90057.0	SILVERGATE (5 SDG&E)	287.0	FISH- ROUND STINGRAY	-9.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-9.00	73.70	-5

APPENDIX D

Grain Size, Total Organic Carbon and Dissolved Organic Carbon

GRAIN SIZE (% fines), TOTAL ORGANIC CARBON (% dry weight) AND DISSOLVED ORGANIC CARBON (uM)

STANUM	STATION	IDORG	DATE	LEG	FINES	FINEBATCH	FINEDATAQC	TOC	TOCBATCH	TOCDATAQC	DOC
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	73.24	B97064	-4	1.65	47	-4	-9
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	62.89	B97064	-4	1.61	47	-4	-9
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	81.14	B97064	-4	2.28	47	-4	-9
90039.0	CL	1676	12/3/96	47.0	18.21	B97064	-4	11.98	47	-4	-9
93179.0	NAVAL SHIPYARDS O3 (x1)	1677	12/3/96	47.0	78.58	B97064	-4	2.48	47	-4	-9
90020.0	G DE LAPPE	1678	12/3/96	47.0	82.49	B97064	-4	2.41	47	-4	-9
93178.0	NAVAL SHIPYARDS O2 (x1)	1679	12/3/96	47.0	43.25	B97064	-4	2.22	47	-4	-9
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	94.20	B97064	-4	1.29	47	-4	-9
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47.0	50.98	B97064	-4	1.05	47	-4	752

APPENDIX E

Toxicity Data

SECTION I

Eohaustorius estuarius Solid Phase Survival

Eohaustorius estuarius PERCENT SURVIVAL SOLID PHASE TEST, AND WATER QUALITY (mg/L)

STANUM	STATION	IDORG	DATE	LEG	METADATA	CTRL	EE_MN	EE_SD	EE_SG	EE_TOX	EE_BATCH	EEQC	EE_OTNH3
	CONTROL			47.0	toxdata7.wpd	C1	99.00	2.00	-9	-9	147tee	-4	3.400
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	toxdata7.wpd	C1	87.00	8.00	*	NT	147tee	-3	-8.000
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	toxdata7.wpd	C1	91.00	2.00	*	NT	147tee	-3	0.290
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	toxdata7.wpd	C1	83.00	21.00	ns	NT	147tee	-3	0.150
90039.0	CL	1676	12/3/96	47.0	toxdata7.wpd	C1	22.00	39.00	*	T	147tee	-3	0.840
93179.0	NAVAL SHIPYARDS O3 (X1)	1677	12/3/96	47.0	toxdata7.wpd	C1	87.00	8.00	*	NT	147tee	-3	0.360
90020.0	G DE LAPPE	1678	12/3/96	47.0	toxdata7.wpd	C1	66.00	37.00	ns	NT	147tee	-3	3.300
93178.0	NAVAL SHIPYARDS O2 (X1)	1679	12/3/96	47.0	toxdata7.wpd	C1	88.00	14.00	ns	NT	147tee	-3	2.000
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	toxdata7.wpd	C1	83.00	8.00	*	NT	147tee	-4	0.920
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47.0	toxdata7.wpd	C1	84.00	4.00	*	NT	147tee	-4	2.300

Eohaustorius estuarius PERCENT SURVIVAL SOLID PHASE TEST, AND WATER QUALITY (mg/L)

STANUM	STATION	IDORG	DATE	LEG	EE_OUNH3	EE_OH2S	EE_ITNH3	EE_IUNH3	EE_IH2S
	CONTROL			47.0	0.077	-9.0000	-9.000	-9.000	-9.0000
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	-8.000	-9.0000	0.950	0.012	0.0079
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	0.008	-9.0000	0.700	0.020	-8.0000
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	0.003	-9.0000	1.400	0.013	0.0070
90039.0	CL	1676	12/3/96	47.0	0.056	-9.0000	3.600	0.063	0.2693
93179.0	NAVAL SHIPYARDS O3 (X1)	1677	12/3/96	47.0	0.007	-9.0000	1.000	0.031	0.0070
90020.0	G DE LAPPE	1678	12/3/96	47.0	0.064	-9.0000	1.900	0.019	0.0498
93178.0	NAVAL SHIPYARDS O2 (X1)	1679	12/3/96	47.0	0.042	-9.0000	2.800	0.040	0.6457
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	0.020	-9.0000	1.700	0.016	0.1727
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47.0	0.069	-9.0000	2.700	0.017	0.0707

SECTION II

Strongylocentrotus purpuratus Development in Sediment/Water Interface

Strongylocentrotus purpuratus PERCENT NORMAL DEVELOPMENT IN SEDIMENT/WATER INTERFACE, AND WATER QUALITY (mg/L)

STANUM	STATION	IDORG	DATE	LEG	METADATA	CTRL	SPDI_MN	SPDI_SD	SPDI_SG	SPDI_TOX	SPDI_BATCH	SPDIQC
	CONTROL			47.0	toxdata7.wpd	C1	97.00	1.00	-9	-9	147tspdswi	-3
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	toxdata7.wpd	C1	76.00	40.00	ns	NT	147tspdswi	-3
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	toxdata7.wpd	C1	94.00	5.00	ns	NT	147tspdswi	-3
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	toxdata7.wpd	C1	43.00	32.00	*	T	147tspdswi	-3
90039.0	CL	1676	12/3/96	47.0	toxdata7.wpd	C1	38.00	51.00	*	T	147tspdswi	-4
93179.0	NAVAL SHIPYARDS O3 (X1)	1677	12/3/96	47.0	toxdata7.wpd	C1	74.00	32.00	ns	NT	147tspdswi	-3
90020.0	G DE LAPPE	1678	12/3/96	47.0	toxdata7.wpd	C1	57.00	36.00	*	NT	147tspdswi	-3
93178.0	NAVAL SHIPYARDS O2 (X1)	1679	12/3/96	47.0	toxdata7.wpd	C1	2.00	4.00	*	T	147tspdswi	-4
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	toxdata7.wpd	C1	78.00	44.00	ns	NT	147tspdswi	-3
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47.0	toxdata7.wpd	C1	67.00	12.00	*	NT	147tspdswi	-4

Strongylocentrotus purpuratus PERCENT NORMAL DEVELOPMENT IN SEDIMENT/WATER INTERFACE, AND WATER QUALITY (mg/L)

STANUM	STATION	IDORG	DATE	LEG	SPDI_OTNH3	SPDI_OUNH3	SPDI_OH2S
	CONTROL			47.0	-8.000	-8.000	0.0010
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	0.270	0.008	0.0499
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	0.250	0.003	0.0055
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	0.420	0.004	0.0077
90039.0	CL	1676	12/3/96	47.0	0.150	0.001	0.2774
93179.0	NAVAL SHIPYARDS O3 (X1)	1677	12/3/96	47.0	-8.000	-8.000	0.0016
90020.0	G DE LAPPE	1678	12/3/96	47.0	0.100	0.003	0.0004
93178.0	NAVAL SHIPYARDS O2 (X1)	1679	12/3/96	47.0	0.990	0.010	0.0163
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	0.960	0.010	0.0066
95006.0	LOS PEN ASQUITOS (319)	1681	12/4/96	47.0	0.690	0.004	0.0053

APPENDIX F

Benthic Community Analysis Data

BENTHIC COMMUNITY ANALYSES: STATISTICAL ANALYSIS

STANUM	STATION	IDORG	DATE	LEG
90007	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/03/96	47

Species	Taxa	# of Sp.	Number per core			Summary Statistics							
			rep 1	rep 2	rep 3	mean	median	min	max	St. Dev.	S.E.	95%CL	sum
Amphideutopus oculatus	Gammaridea		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Grandidierella japonica	Gammaridea		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Synchelidium sp.	Gammaridea		1	0	1	0.7	0.5	0	1	0.6	0.3	1.3	2
Euphilomedes carcharodonta	Ostracoda		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Leptognathia sp.	Tanaidacea		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Theora fragilis	Bivalvia		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Armandia brevis	Polychaeta		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Caulleriella pacifica	Polychaeta		3	0	2	1.7	1.5	0	3	1.5	0.9	3.4	5
Cossura candida	Polychaeta		0	1	1	0.7	0.5	0	1	0.6	0.3	1.3	2
Diplocirrus sp.	Polychaeta		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Dorvillea longicornis	Polychaeta		1	0	1	0.7	0.5	0	1	0.6	0.3	1.3	2
Eteone lighti	Polychaeta		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Euchone limnicola	Polychaeta		3	0	1	1.3	1.5	0	3	1.5	0.9	3.4	4
Exogone lourei	Polychaeta		1	1	3	1.7	2.0	1	3	1.2	0.7	2.6	5
Harmothoinae spp. indet.	Polychaeta		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Leitoscoloplos pugettensis	Polychaeta		11	0	1	4.0	5.5	0	11	6.1	3.5	13.7	12
Mediomastus ambiseta	Polychaeta		1	2	0	1.0	1.0	0	2	1.0	0.6	2.3	3
Mediomastus californiensis	Polychaeta		6	3	1	3.3	3.5	1	6	2.5	1.5	5.7	10
Mediomastus sp(p)	Polychaeta		2	1	0	1.0	1.0	0	2	1.0	0.6	2.3	3
Nephtys cornuta	Polychaeta		6	0	2	2.7	3.0	0	6	3.1	1.8	6.9	8
Nereis procera	Polychaeta		0	1	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Odontosyllis phosphorea	Polychaeta		5	0	0	1.7	2.5	0	5	2.9	1.7	6.5	5
Paraprionospio pinnata	Polychaeta		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Pista alata	Polychaeta		2	0	1	1.0	1.0	0	2	1.0	0.6	2.3	3
Poecilochaetus sp. A	Polychaeta		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Prionospio heterobranchia	Polychaeta		20	1	14	11.7	10.5	1	20	9.7	5.6	21.9	35
Pseudopolydora paucibranchiata	Polychaeta		0	2	0	0.7	1.0	0	2	1.2	0.7	2.6	2
Scolelepis spp. indet.	Polychaeta		1	0	3	1.3	1.5	0	3	1.5	0.9	3.4	4
Scoletoma tetraura	Polychaeta		3	2	1	2.0	2.0	1	3	1.0	0.6	2.3	6
Scoletoma zonata	Polychaeta		2	2	1	1.7	1.5	1	2	0.6	0.3	1.3	5
Nemertea	Nemertea		41	0	0	13.7	20.5	0	41	23.7	13.7	53.3	41
Oligochaeta	Oligochaeta		0	1	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Total Individuals		0	115	17	38	56.7	66.0	17	115	51.6	29.8	116.1	170
Total Species		32	23	11	19	17.7	17.0	11	23	6.1	3.5	13.7	53

BENTHIC COMMUNITY ANALYSES: STATISTICAL ANALYSIS

STANUM	STATION	IDORG	DATE	LEG
90007	25 SWARTZ (NAVAL BASE/SY O10) (cont.)	1673	12/03/96	47

Species	Taxa	# of Sp.	Number per core rep 1	rep 2	rep 3	Summary Statistics mean	median	min	max	St. Dev.	S.E.	95%CL	sum
Total Crust. Indiv.			2	0	4	2.0	2.0	0	4	2.0	1.2	4.5	6
Total Crust. Sp.		5	2	0	4	2.0	2.0	0	4	2.0	1.2	4.5	6
Gammarid Indiv.			2	0	2	1.3	1.0	0	2	1.2	0.7	2.6	4
Gammarid Sp.		3	2	0	2	1.3	1.0	0	2	1.2	0.7	2.6	4
Other Crustacean Indiv.			0	0	2	0.7	1.0	0	2	1.2	0.7	2.6	2
Other Crustacean Sp.		2	0	0	2	0.7	1.0	0	2	1.2	0.7	2.6	2
Total Echinoderm Indiv.			0	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0
Total Echinoderm Sp.		0	0	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0
Total Mollusc Indiv.			0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Total Mollusc Sp.		1	0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Total Polychaete Indiv.			72	16	33	40.3	44.0	16	72	28.7	16.6	64.6	121
Total Polychaete Sp.		24	20	10	14	14.7	15.0	10	20	5.0	2.9	11.3	44

STANUM	STATION	IDORG	DATE	LEG
90008	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/03/96	47

Species	Taxa	# of Sp.	Number per core rep 1	rep 2	rep 3	Summary Statistics mean	median	min	max	St. Dev.	S.E.	95%CL	sum
Heptacarpus sp.	Decapoda		1	1	0	0.7	0.5	0	1	0.6	0.3	1.3	2
Amphideutopus oculatus	Gammaridea		0	2	0	0.7	1.0	0	2	1.2	0.7	2.6	2
Grandidierella japonica	Gammaridea		1	1	0	0.7	0.5	0	1	0.6	0.3	1.3	2
Synchelidium sp.	Gammaridea		1	2	0	1.0	1.0	0	2	1.0	0.6	2.3	3
Theora fragilis	Bivalvia		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Armandia brevis	Polychaeta		0	1	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Caulleriella pacifica	Polychaeta		0	1	3	1.3	1.5	0	3	1.5	0.9	3.4	4
Cossura candida	Polychaeta		1	3	2	2.0	2.0	1	3	1.0	0.6	2.3	6
Cossura pygodactylata	Polychaeta		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Diplocirrus sp.	Polychaeta		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Dorvillea longicornis	Polychaeta		1	0	1	0.7	0.5	0	1	0.6	0.3	1.3	2
Eteone lighti	Polychaeta		0	1	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Euchone limnicola	Polychaeta		0	4	0	1.3	2.0	0	4	2.3	1.3	5.2	4

BENTHIC COMMUNITY ANALYSES: STATISTICAL ANALYSIS

STANUM	STATION	IDORG	DATE	LEG
90008	27 SWARTZ (NAVAL BASE/SH O13) (cont.)	1674	12/03/96	47

Species	Taxa	# of Sp.	Number per core rep 1	rep 2	rep 3	Summary Statistics mean	median	min	max	St. Dev.	S.E.	95%CL	sum
Exogone lourei	Polychaeta		2	0	1	1.0	1.0	0	2	1.0	0.6	2.3	3
Leitoscoloplos pugettensis	Polychaeta		2	3	4	3.0	3.0	2	4	1.0	0.6	2.3	9
Mediomastus californiensis	Polychaeta		10	5	4	6.3	7.0	4	10	3.2	1.9	7.2	19
Mediomastus sp(p)	Polychaeta		11	0	0	3.7	5.5	0	11	6.4	3.7	14.3	11
Nephtys cornuta	Polychaeta		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Nereis procera	Polychaeta		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Odontosyllis phosphorea	Polychaeta		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Prionospio heterobranchia	Polychaeta		6	11	15	10.7	10.5	6	15	4.5	2.6	10.1	32
Prionospio lighti	Polychaeta		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Pseudopolydora paucibranchiata	Polychaeta		4	1	1	2.0	2.5	1	4	1.7	1.0	3.9	6
Scolelepis spp. indet.	Polychaeta		2	0	3	1.7	1.5	0	3	1.5	0.9	3.4	5
Scoletoma tetraura	Polychaeta		5	2	1	2.7	3.0	1	5	2.1	1.2	4.7	8
Oligochaeta	Oligochaeta		1	1	0	0.7	0.5	0	1	0.6	0.3	1.3	2
Total Individuals			50	39	40	43.0	44.5	39	50	6.1	3.5	13.7	129
Total Species		26	16	15	15	15.3	15.5	15	16	0.6	0.3	1.3	46
Total Crust. Indiv.			3	6	0	3.0	3.0	0	6	3.0	1.7	6.8	9
Total Crust. Sp.		4	3	4	0	2.3	2.0	0	4	2.1	1.2	4.7	7
Gammarid Indiv.			2	5	0	2.3	2.5	0	5	2.5	1.5	5.7	7
Gammarid Sp.		3	2	3	0	1.7	1.5	0	3	1.5	0.9	3.4	5
Other Crustacean Indiv.			1	1	0	0.7	0.5	0	1	0.6	0.3	1.3	2
Other Crustacean Sp.		1	1	1	0	0.7	0.5	0	1	0.6	0.3	1.3	2
Total Echinoderm Indiv.			0	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0
Total Echinoderm Sp.		0	0	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0
Total Mollusc Indiv.			0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Total Mollusc Sp.		1	0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Total Polychaete Indiv.			46	32	39	39.0	39.0	32	46	7.0	4.0	15.8	117
Total Polychaete Sp.		20	12	10	14	12.0	12.0	10	14	2.0	1.2	4.5	36

BENTHIC COMMUNITY ANALYSES: STATISTICAL ANALYSIS

STANUM	STATION	IDORG	DATE	LEG
90022	P SWARTZ (NAVAL BASE O12)	1675	12/03/96	47

Species	Taxa	# of Sp.	Number per core rep 1	rep 2	rep 3	Summary Statistics mean	median	min	max	St. Dev.	S.E.	95%CL	sum
Heptacarpus sp.	Decapoda		1	0	1	0.7	0.5	0	1	0.6	0.3	1.3	2
Grandidierella japonica	Gammaridea		14	21	4	13.0	12.5	4	21	8.5	4.9	19.2	39
Rudilemboides stenopropodus	Gammaridea		0	2	0	0.7	1.0	0	2	1.2	0.7	2.6	2
Synchelidium sp.	Gammaridea		0	1	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Euphilomedes carcharodonta	Ostracoda		0	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0
Theora fragilis	Bivalvia		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Acteocina sp.	Gastropoda		7	1	0	2.7	3.5	0	7	3.8	2.2	8.5	8
Nassarius sp.	Gastropoda		0	1	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Aphelochaeta sp(p)	Polychaeta		0	1	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Armandia brevis	Polychaeta		0	1	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Caulleriella pacifica	Polychaeta		0	3	0	1.0	1.5	0	3	1.7	1.0	3.9	3
Cossura candida	Polychaeta		1	1	1	1.0	1.0	1	1	0.0	0.0	0.0	3
Cossura pygodactylata	Polychaeta		6	2	2	3.3	4.0	2	6	2.3	1.3	5.2	10
Diplocirrus sp.	Polychaeta		1	0	1	0.7	0.5	0	1	0.6	0.3	1.3	2
Dorvillea longicornis	Polychaeta		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Euchone limnicola	Polychaeta		0	0	6	2.0	3.0	0	6	3.5	2.0	7.8	6
Exogone lourei	Polychaeta		2	0	1	1.0	1.0	0	2	1.0	0.6	2.3	3
Glycera americana	Polychaeta		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Leitoscoloplos pugettensis	Polychaeta		6	1	4	3.7	3.5	1	6	2.5	1.5	5.7	11
Mediomastus ambiseta	Polychaeta		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Mediomastus californiensis	Polychaeta		7	3	6	5.3	5.0	3	7	2.1	1.2	4.7	16
Mediomastus sp(p)	Polychaeta		1	1	0	0.7	0.5	0	1	0.6	0.3	1.3	2
Microspio pigmentata	Polychaeta		1	1	0	0.7	0.5	0	1	0.6	0.3	1.3	2
Nephtys cornuta	Polychaeta		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Nereis procera	Polychaeta		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Odontosyllis phosphorea	Polychaeta		4	2	1	2.3	2.5	1	4	1.5	0.9	3.4	7
Prionospio heterobranchia	Polychaeta		12	5	6	7.7	8.5	5	12	3.8	2.2	8.5	23
Pseudopolydora paucibranchiata	Polychaeta		4	3	7	4.7	5.0	3	7	2.1	1.2	4.7	14
Scolelepis spp. indet.	Polychaeta		1	0	2	1.0	1.0	0	2	1.0	0.6	2.3	3
Scoletoma tetraura	Polychaeta		0	1	1	0.7	0.5	0	1	0.6	0.3	1.3	2
Scoletoma zonata	Polychaeta		7	5	6	6.0	6.0	5	7	1.0	0.6	2.3	18
Nemertea	Nemertea		2	0	0	0.7	1.0	0	2	1.2	0.7	2.6	2
Oligochaeta	Oligochaeta		7	0	1	2.7	3.5	0	7	3.8	2.2	8.5	8
Total Individuals			86	56	54	65.3	70.0	54	86	17.9	10.3	40.3	196

BENTHIC COMMUNITY ANALYSES: STATISTICAL ANALYSIS

STANUM	STATION	IDORG	DATE	LEG
90022	P SWARTZ (NAVAL BASE O12) (cont.)	1675	12/03/96	47

Species	Taxa	# of Sp.	Number per core rep 1	rep 2	rep 3	Summary Statistics mean	median	min	max	St. Dev.	S.E.	95%CL	sum
Total Species		33	20	19	20	19.7	19.5	19	20	0.6	0.3	1.3	59
Total Crust. Indiv.			15	24	5	14.7	14.5	5	24	9.5	5.5	21.4	44
Total Crust. Sp.		5	2	3	2	2.3	2.5	2	3	0.6	0.3	1.3	7
Gammarid Indiv.			14	24	4	14.0	14.0	4	24	10.0	5.8	22.5	42
Gammarid Sp.		3	1	3	1	1.7	2.0	1	3	1.2	0.7	2.6	5
Other Crustacean Indiv.			1	0	1	0.7	0.5	0	1	0.6	0.3	1.3	2
Other Crustacean Sp.		2	1	0	1	0.7	0.5	0	1	0.6	0.3	1.3	2
Total Echinoderm Indiv.			0	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0
Total Echinoderm Sp.		0	0	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0
Total Mollusc Indiv.			7	2	1	3.3	4.0	1	7	3.2	1.9	7.2	10
Total Mollusc Sp.		3	1	2	1	1.3	1.5	1	2	0.6	0.3	1.3	4
Total Polychaete Indiv.			55	30	47	44.0	42.5	30	55	12.8	7.4	28.7	132
Total Polychaete Sp.		23	15	14	16	15.0	15.0	14	16	1.0	0.6	2.3	45

STANUM	STATION	IDORG	DATE	LEG
90039	CL	1676	12/03/96	47

Species	Taxa	# of Sp.	Number per core rep 1	rep 2	rep 3	Summary Statistics mean	median	min	max	St. Dev.	S.E.	95%CL	sum
Musculista senhousei	Bivalvia		0	1	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Capitella capitata	Polychaeta		11	1	21	11.0	11.0	1	21	10.0	5.8	22.5	33
Caulleriella pacifica	Polychaeta		4	0	0	1.3	2.0	0	4	2.3	1.3	5.2	4
Cossura candida	Polychaeta		2	0	0	0.7	1.0	0	2	1.2	0.7	2.6	2
Dorvillea longicornis	Polychaeta		22	0	4	8.7	11.0	0	22	11.7	6.8	26.4	26
Exogone lourei	Polychaeta		1	0	1	0.7	0.5	0	1	0.6	0.3	1.3	2
Neanthes acuminata	Polychaeta		2	1	5	2.7	3.0	1	5	2.1	1.2	4.7	8
Syllides spp. juv.	Polychaeta		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Nematoda	Nematoda		5	0	0	1.7	2.5	0	5	2.9	1.7	6.5	5
Nemertea	Nemertea		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Oligochaeta	Oligochaeta		8	1	10	6.3	5.5	1	10	4.7	2.7	10.6	19

BENTHIC COMMUNITY ANALYSES: STATISTICAL ANALYSIS

STANUM	STATION	IDORG	DATE	LEG
90039	CL (cont.)	1676	12/03/96	47

Species	Taxa	# of Sp.	Number per core rep 1	rep 2	rep 3	Summary Statistics mean	median	min	max	St. Dev.	S.E.	95%CL	sum
Total Individuals			57	4	41	34.0	30.5	4	57	27.2	15.7	61.2	102
Total Species		11	10	4	5	6.3	7.0	4	10	3.2	1.9	7.2	19
Total Crust. Indiv.			0	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0
Total Crust. Sp.		0	0	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0
Gammarid Indiv.			0	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0
Gammarid Sp.		0	0	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0
Other Crustacean Indiv.			0	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0
Other Crustacean Sp.		0	0	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0
Total Echinoderm Indiv.			0	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0
Total Echinoderm Sp.		0	0	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0
Total Mollusc Indiv.			0	1	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Total Mollusc Sp.		1	0	1	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Total Polychaete Indiv.			43	2	31	25.3	22.5	2	43	21.1	12.2	47.4	76
Total Polychaete Sp.		7	7	2	4	4.3	4.5	2	7	2.5	1.5	5.7	13

STANUM	STATION	IDORG	DATE	LEG
93179	NAVAL SHIPYARDS O3 (x1)	1677	12/03/96	47

Species	Taxa	# of Sp.	Number per core rep 1	rep 2	rep 3	Summary Statistics mean	median	min	max	St. Dev.	S.E.	95%CL	sum
Neotrypaea californiensis	Decapoda		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Amphideutopus oculatus	Gammaridea		1	1	0	0.7	0.5	0	1	0.6	0.3	1.3	2
Corophium acherusicum	Gammaridea		0	2	0	0.7	1.0	0	2	1.2	0.7	2.6	2
Grandidierella japonica	Gammaridea		15	14	11	13.3	13.0	11	15	2.1	1.2	4.7	40
Hippomedon sp.	Gammaridea		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Rudilemboides stenopropodus	Gammaridea		3	0	0	1.0	1.5	0	3	1.7	1.0	3.9	3
Synchelidium rectipalmum	Gammaridea		6	3	0	3.0	3.0	0	6	3.0	1.7	6.8	9
Euphilomedes carcharodonta	Ostracoda		0	2	0	0.7	1.0	0	2	1.2	0.7	2.6	2
Parasterope sp	Ostracoda		0	0	19	6.3	9.5	0	19	11.0	6.3	24.7	19
Pycnogonida	Pycnogonida		0	1	0	0.3	0.5	0	1	0.6	0.3	1.3	1

93179	NAVAL SHIPYARDS O3 (x1) (cont.)	1677	12/03/96	47

Species	Taxa	# of Sp.	Number per core rep 1	rep 2	rep 3	Summary Statistics mean	median	min	max	St. Dev.	S.E.	95%CL	sum
Total Mollusc Indiv.			1	11	3	5.0	6.0	1	11	5.3	3.1	11.9	15
Total Mollusc Sp.		2	1	1	1	1.0	1.0	1	1	0.0	0.0	0.0	3
Total Polychaete Indiv.			86	86	27	66.3	56.5	27	86	34.1	19.7	76.6	199
Total Polychaete Sp.		18	15	9	6	10.0	10.5	6	15	4.6	2.6	10.3	30

STANUM	STATION	IDORG	DATE	LEG
90020	G DE LAPPE	1678	12/03/96	47

Species	Taxa	# of Sp.	Number per core rep 1	rep 2	rep 3	Summary Statistics mean	median	min	max	St. Dev.	S.E.	95%CL	sum
Amphideutopus oculatus	Gammaridea		1	3	4	2.7	2.5	1	4	1.5	0.9	3.4	8
Grandidierella japonica	Gammaridea		3	0	2	1.7	1.5	0	3	1.5	0.9	3.4	5
Rudilemboides stenopropodus	Gammaridea		7	3	4	4.7	5.0	3	7	2.1	1.2	4.7	14
Synchelidium rectipalmum	Gammaridea		0	4	2	2.0	2.0	0	4	2.0	1.2	4.5	6
Parasterope sp	Ostracoda		0	1	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Leptochelia dubia	Tanaidacea		1	0	5	2.0	2.5	0	5	2.6	1.5	6.0	6
Leptognathia sp.	Tanaidacea		1	1	0	0.7	0.5	0	1	0.6	0.3	1.3	2
Zeuxo normani	Tanaidacea		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Musculista senhousei	Bivalvia		2	7	5	4.7	4.5	2	7	2.5	1.5	5.7	14
Theora fragilis	Bivalvia		4	7	6	5.7	5.5	4	7	1.5	0.9	3.4	17
Acteocina sp.	Gastropoda		1	0	1	0.7	0.5	0	1	0.6	0.3	1.3	2
Armandia brevis	Polychaeta		0	2	0	0.7	1.0	0	2	1.2	0.7	2.6	2
Brania brevipharyngea	Polychaeta		0	1	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Capitella capitata	Polychaeta		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Cossura candida	Polychaeta		4	0	0	1.3	2.0	0	4	2.3	1.3	5.2	4
Cossura pygodactylata	Polychaeta		6	2	4	4.0	4.0	2	6	2.0	1.2	4.5	12
Dorvillea longicornis	Polychaeta		2	0	0	0.7	1.0	0	2	1.2	0.7	2.6	2
Euchone limnicola	Polychaeta		1	1	0	0.7	0.5	0	1	0.6	0.3	1.3	2
Eupolymnia spp. juv.	Polychaeta		0	2	0	0.7	1.0	0	2	1.2	0.7	2.6	2
Exogone lourei	Polychaeta		8	23	10	13.7	15.5	8	23	8.1	4.7	18.3	41
Glycera spp. juv.	Polychaeta		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Leitoscoloplos pugettensis	Polychaeta		24	14	15	17.7	19.0	14	24	5.5	3.2	12.4	53

93179	NAVAL SHIPYARDS O3 (x1) (cont.)	1677	12/03/96	47										
	Species	Taxa	# of Sp.	Number per core			Summary Statistics							
				rep 1	rep 2	rep 3	mean	median	min	max	St. Dev.	S.E.	95%CL	sum
	Total Mollusc Indiv.			1	11	3	5.0	6.0	1	11	5.3	3.1	11.9	15
	Total Mollusc Sp.		2	1	1	1	1.0	1.0	1	1	0.0	0.0	0.0	3
	Total Polychaete Indiv.			86	86	27	66.3	56.5	27	86	34.1	19.7	76.6	199
	Total Polychaete Sp.		18	15	9	6	10.0	10.5	6	15	4.6	2.6	10.3	30

STANUM	STATION	IDORG	DATE	LEG										
90020	G DE LAPPE	1678	12/03/96	47										
	Species	Taxa	# of Sp.	Number per core			Summary Statistics							
				rep 1	rep 2	rep 3	mean	median	min	max	St. Dev.	S.E.	95%CL	sum
	Amphideutopus oculatus	Gammaridea		1	3	4	2.7	2.5	1	4	1.5	0.9	3.4	8
	Grandidierella japonica	Gammaridea		3	0	2	1.7	1.5	0	3	1.5	0.9	3.4	5
	Rudilemboides stenopropodus	Gammaridea		7	3	4	4.7	5.0	3	7	2.1	1.2	4.7	14
	Synchelidium rectipalmum	Gammaridea		0	4	2	2.0	2.0	0	4	2.0	1.2	4.5	6
	Parasterope sp	Ostracoda		0	1	0	0.3	0.5	0	1	0.6	0.3	1.3	1
	Leptochelia dubia	Tanaidacea		1	0	5	2.0	2.5	0	5	2.6	1.5	6.0	6
	Leptognathia sp.	Tanaidacea		1	1	0	0.7	0.5	0	1	0.6	0.3	1.3	2
	Zeuxo normani	Tanaidacea		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
	Musculista senhousei	Bivalvia		2	7	5	4.7	4.5	2	7	2.5	1.5	5.7	14
	Theora fragilis	Bivalvia		4	7	6	5.7	5.5	4	7	1.5	0.9	3.4	17
	Acteocina sp.	Gastropoda		1	0	1	0.7	0.5	0	1	0.6	0.3	1.3	2
	Armandia brevis	Polychaeta		0	2	0	0.7	1.0	0	2	1.2	0.7	2.6	2
	Brania brevipharyngea	Polychaeta		0	1	0	0.3	0.5	0	1	0.6	0.3	1.3	1
	Capitella capitata	Polychaeta		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
	Cossura candida	Polychaeta		4	0	0	1.3	2.0	0	4	2.3	1.3	5.2	4
	Cossura pygodactylata	Polychaeta		6	2	4	4.0	4.0	2	6	2.0	1.2	4.5	12
	Dorvillea longicornis	Polychaeta		2	0	0	0.7	1.0	0	2	1.2	0.7	2.6	2
	Euchone limnicola	Polychaeta		1	1	0	0.7	0.5	0	1	0.6	0.3	1.3	2
	Eupolymnia spp. juv.	Polychaeta		0	2	0	0.7	1.0	0	2	1.2	0.7	2.6	2
	Exogone lourei	Polychaeta		8	23	10	13.7	15.5	8	23	8.1	4.7	18.3	41
	Glycera spp. juv.	Polychaeta		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
	Leitoscoloplos pugettensis	Polychaeta		24	14	15	17.7	19.0	14	24	5.5	3.2	12.4	53

STANUM	STATION	IDORG	DATE	LEG
90020	G DE LAPPE (cont.)	1678	12/03/96	47

Species	Taxa	# of Sp.	Number per core rep 1	rep 2	rep 3	Summary Statistics mean	median	min	max	St. Dev.	S.E.	95%CL	sum
Mediomastus ambiseta	Polychaeta		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Mediomastus californiensis	Polychaeta		1	2	1	1.3	1.5	1	2	0.6	0.3	1.3	4
Mediomastus sp(p)	Polychaeta		3	9	6	6.0	6.0	3	9	3.0	1.7	6.8	18
Nephtys cornuta	Polychaeta		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Odontosyllis phosphorea	Polychaeta		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Prionospio heterobranchia	Polychaeta		10	19	24	17.7	17.0	10	24	7.1	4.1	16.0	53
Pseudopolydora paucibranchiata	Polychaeta		9	20	20	16.3	14.5	9	20	6.4	3.7	14.3	49
Scolelepis spp. indet.	Polychaeta		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Scoletoma erecta	Polychaeta		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Scoletoma zonata	Polychaeta		10	17	5	10.7	11.0	5	17	6.0	3.5	13.6	32
Sphaerosyllis californiensis	Polychaeta		3	0	1	1.3	1.5	0	3	1.5	0.9	3.4	4
Nematoda	Nematoda		2	2	6	3.3	4.0	2	6	2.3	1.3	5.2	10
Nemertea	Nemertea		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Oligochaeta	Oligochaeta		1	6	1	2.7	3.5	1	6	2.9	1.7	6.5	8
Total Individuals			109	146	126	127.0	127.5	109	146	18.5	10.7	41.7	381
Total Species		36	27	21	23	23.7	24.0	21	27	3.1	1.8	6.9	71
Total Crust. Indiv.			13	12	18	14.3	15.0	12	18	3.2	1.9	7.2	43
Total Crust. Sp.		8	5	5	6	5.3	5.5	5	6	0.6	0.3	1.3	16
Gammarid Indiv.			11	10	12	11.0	11.0	10	12	1.0	0.6	2.3	33
Gammarid Sp.		4	3	3	4	3.3	3.5	3	4	0.6	0.3	1.3	10
Other Crustacean Indiv.			2	2	6	3.3	4.0	2	6	2.3	1.3	5.2	10
Other Crustacean Sp.		4	2	2	2	2.0	2.0	2	2	0.0	0.0	0.0	6
Total Echinoderm Indiv.			0	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0
Total Echinoderm Sp.		0	0	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0
Total Mollusc Indiv.			7	14	12	11.0	10.5	7	14	3.6	2.1	8.1	33
Total Mollusc Sp.		3	3	2	3	2.7	2.5	2	3	0.6	0.3	1.3	8
Total Polychaete Indiv.			86	112	88	95.3	99.0	86	112	14.5	8.4	32.6	286
Total Polychaete Sp.		22	17	12	11	13.3	14.0	11	17	3.2	1.9	7.2	40

BENTHIC COMMUNITY ANALYSES: STATISTICAL ANALYSIS

STANUM	STATION	IDORG	DATE	LEG
93178	NAVAL SHIPYARDS O2 (x1)	1679	12/03/96	47

Species	Taxa	# of Sp.	Number per core			Summary Statistics							
			rep 1	rep 2	rep 3	mean	median	min	max	St. Dev.	S.E.	95%CL	sum
Neotrypaea californiensis	Decapoda		3	0	0	1.0	1.5	0	3	1.7	1.0	3.9	3
Grandidierella japonica	Gammaridea		17	19	9	15.0	14.0	9	19	5.3	3.1	11.9	45
Rudilemboides stenopropodus	Gammaridea		2	0	0	0.7	1.0	0	2	1.2	0.7	2.6	2
Colanthura squamosissima	Isopoda		0	0	5	1.7	2.5	0	5	2.9	1.7	6.5	5
Paracerceis sculpta	Isopoda		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Uromunna ubiquita	Isopoda		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Euphilomedes carcharodonta	Ostracoda		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Parasterope sp	Ostracoda		0	2	7	3.0	3.5	0	7	3.6	2.1	8.1	9
Zeuxo paranormani	Tanaidacea		2	1	31	11.3	16.0	1	31	17.0	9.8	38.3	34
Bivalve	Bivalvia		1	5	0	2.0	2.5	0	5	2.6	1.5	6.0	6
Musculista senhousei	Bivalvia		0	1	1	0.7	0.5	0	1	0.6	0.3	1.3	2
Theora fragilis	Bivalvia		0	0	3	1.0	1.5	0	3	1.7	1.0	3.9	3
Acteocina sp.	Gastropoda		0	2	1	1.0	1.0	0	2	1.0	0.6	2.3	3
Armandia brevis	Polychaeta		1	4	8	4.3	4.5	1	8	3.5	2.0	7.9	13
Brania brevipharyngea	Polychaeta		5	0	0	1.7	2.5	0	5	2.9	1.7	6.5	5
Capitella capitata	Polychaeta		3	0	0	1.0	1.5	0	3	1.7	1.0	3.9	3
Caulleriella pacifica	Polychaeta		5	28	60	31.0	32.5	5	60	27.6	15.9	62.2	93
Cossura pygodactylata	Polychaeta		2	0	2	1.3	1.0	0	2	1.2	0.7	2.6	4
Dipolydora socialis	Polychaeta		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Dorvillea longicornis	Polychaeta		14	0	0	4.7	7.0	0	14	8.1	4.7	18.2	14
Drilonereis longa	Polychaeta		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Eteone lighti	Polychaeta		3	0	0	1.0	1.5	0	3	1.7	1.0	3.9	3
Exogone lourei	Polychaeta		9	11	48	22.7	28.5	9	48	22.0	12.7	49.4	68
Fabricinuda limnicola	Polychaeta		1	0	13	4.7	6.5	0	13	7.2	4.2	16.3	14
Glycera spp. juv.	Polychaeta		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Leitoscoloplos pugettensis	Polychaeta		4	1	1	2.0	2.5	1	4	1.7	1.0	3.9	6
Lumbrineridae spp. juv.	Polychaeta		2	0	0	0.7	1.0	0	2	1.2	0.7	2.6	2
Mediomastus ambiseta	Polychaeta		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Mediomastus sp(p)	Polychaeta		1	6	3	3.3	3.5	1	6	2.5	1.5	5.7	10
Neanthes acuminata	Polychaeta		6	12	11	9.7	9.0	6	12	3.2	1.9	7.2	29
Odontosyllis phosphorea	Polychaeta		1	0	0	0.3	0.5	0	1	0.6	0.3	1.3	1
Polydora cornuta	Polychaeta		7	5	22	11.3	13.5	5	22	9.3	5.4	20.9	34
Prionospio heterobranchia	Polychaeta		8	7	14	9.7	10.5	7	14	3.8	2.2	8.5	29
Pseudopolydora paucibranchiata	Polychaeta		97	44	108	83.0	76.0	44	108	34.2	19.8	77.0	249

BENTHIC COMMUNITY ANALYSES: STATISTICAL ANALYSIS

STANUM	STATION	IDORG	DATE	LEG
93178	NAVAL SHIPYARDS O2 (x1) (cont.)	1679	12/03/96	47

Species	Taxa	# of Sp.	Number per core			Summary Statistics							
			rep 1	rep 2	rep 3	mean	median	min	max	St. Dev.	S.E.	95%CL	sum
Scoletoma tetraura	Polychaeta		0	1	3	1.3	1.5	0	3	1.5	0.9	3.4	4
Scoletoma zonata	Polychaeta		5	4	1	3.3	3.0	1	5	2.1	1.2	4.7	10
Strehlosoma sp. B	Polychaeta		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Nemertea	Nemertea		0	0	1	0.3	0.5	0	1	0.6	0.3	1.3	1
Oligochaeta	Oligochaeta		1	0	6	2.3	3.0	0	6	3.2	1.9	7.2	7
Total Individuals			204	153	362	239.7	257.5	153	362	109.0	62.9	245.2	719
Total Species		39	28	17	26	23.7	22.5	17	28	5.9	3.4	13.2	71
Total Crust. Indiv.			25	22	54	33.7	38.0	22	54	17.7	10.2	39.8	101
Total Crust. Sp.		9	5	3	6	4.7	4.5	3	6	1.5	0.9	3.4	14
Gammarid Indiv.			19	19	9	15.7	14.0	9	19	5.8	3.3	13.0	47
Gammarid Sp.		2	2	1	1	1.3	1.5	1	2	0.6	0.3	1.3	4
Other Crustacean Indiv.			6	3	45	18.0	24.0	3	45	23.4	13.5	52.7	54
Other Crustacean Sp.		7	3	2	5	3.3	3.5	2	5	1.5	0.9	3.4	10
Total Echinoderm Indiv.			0	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0
Total Echinoderm Sp.		0	0	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0
Total Mollusc Indiv.			1	8	5	4.7	4.5	1	8	3.5	2.0	7.9	14
Total Mollusc Sp.		4	1	3	3	2.3	2.0	1	3	1.2	0.7	2.6	7
Total Polychaete Indiv.			177	123	296	198.7	209.5	123	296	88.5	51.1	199.2	596
Total Polychaete Sp.		24	21	11	15	15.7	16.0	11	21	5.0	2.9	11.3	47

STANUM	STATION	IDORG	DATE	LEG
90013	37 SWARTZ (MARINA)	1680	12/03/96	47

Species	Taxa	# of Sp.	Number per core			Summary Statistics							
			rep 1	rep 2	rep 3	mean	median	min	max	St. Dev.	S.E.	95%CL	sum
Campylaspis sp.	Cumacea		1	1	0	0.7	0.5	0	1	0.6	0.3	1.3	2
Leptostylis sp.	Cumacea		6	0	1	2.3	3.0	0	6	3.2	1.9	7.2	7
Neotrypaea californiensis	Decapoda		0	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0
Acuminodeutopus oculatus	Gammaridea		19	26	15	20.0	20.5	15	26	5.6	3.2	12.5	60
Rudilemboides stenopropodus	Gammaridea		55	30	24	36.3	39.5	24	55	16.4	9.5	37.0	109
Synchelidium rectipalmum	Gammaridea		3	1	0	1.3	1.5	0	3	1.5	0.9	3.4	4

APPENDIX G

Corrected P450 Response

PCB CONGENER AND AROCLOR ANALYSIS OF SEDIMENTS (dry weight-ppb-ng/g)

STANUM	STATION	IDORG	DATE	LEG	PCB170	PCB174	PCB177	PCB180	PCB183	PCB187	PCB189	PCB194	PCB195	PCB201
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	13.900	7.150	3.240	13.900	3.010	9.260	1.520	-8.000	3.720	5.180
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	8.000	3.880	2.200	7.270	1.520	5.470	2.150	5.100	1.450	4.860
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	9.300	10.400	4.720	19.900	3.780	11.900	-8.000	10.800	3.570	6.550
90039.0	CL	1676	12/3/96	47.0	15.600	4.560	0.928	13.300	1.200	1.990	-8.000	17.300	1.260	3.450
93179.0	NAVAL SHIPYARDS O3 (x1)	1677	12/3/96	47.0	21.500	16.700	6.620	36.800	9.190	23.500	1.450	11.500	14.200	19.200
90020.0	G DE LAPPE	1678	12/3/96	47.0	39.200	30.400	13.600	62.100	16.300	35.100	-8.000	14.100	7.600	15.400
93178.0	NAVAL SHIPYARDS O2 (x1)	1679	12/3/96	47.0	22.090	18.196	6.850	39.295	9.975	22.070	1.672	13.993	3.666	11.935
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	0.798	0.665	0.601	2.610	0.757	3.000	-8.000	3.760	0.638	0.664
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47.0	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000

PCB CONGENER AND AROCLOR ANALYSIS OF SEDIMENTS (dry weight-ppb-ng/g)

STANUM	STATION	IDORG	DATE	LEG	PCB128	PCB132	PCB137	PCB138	PCB149	PCB151	PCB153	PCB156	PCB157	PCB158
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	4.160	3.980	1.870	26.600	15.700	4.260	30.200	1.600	1.040	2.340
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	1.680	3.080	0.629	13.500	7.390	2.230	17.100	-8.000	0.717	1.280
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	4.600	3.500	-8.000	34.800	24.800	5.500	39.300	1.690	1.100	-8.000
90039.0	CL	1676	12/3/96	47.0	2.480	1.950	-8.000	28.200	7.680	0.983	8.470	-8.000	-8.000	1.180
93179.0	NAVAL SHIPYARDS O3 (x1)	1677	12/3/96	47.0	18.300	21.900	4.900	91.700	67.200	14.000	75.700	9.120	2.620	9.950
90020.0	G DE LAPPE	1678	12/3/96	47.0	46.900	63.100	12.900	182.000	167.000	34.700	177.000	26.700	6.210	24.000
93178.0	NAVAL SHIPYARDS O2 (x1)	1679	12/3/96	47.0	26.282	23.423	6.674	132.379	96.284	19.650	107.412	14.622	3.537	12.161
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	0.653	0.854	0.081	5.470	2.100	0.677	5.330	-8.000	0.125	0.199
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47.0	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000

PCB CONGENER AND AROCLOR ANALYSIS OF SEDIMENTS (dry weight-ppb-ng/g)

STANUM	STATION	IDORG	DATE	LEG	PCB66	PCB70	PCB74	PCB87	PCB95	PCB97	PCB99	PCB101	PCB105	PCB110	PCB118
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	2.100	2.380	0.908	-9.000	9.130	3.790	6.420	18.500	5.910	15.700	17.900
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	1.240	0.876	0.434	-9.000	4.170	1.530	3.520	6.710	2.840	6.090	8.340
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	3.560	3.150	1.020	-9.000	11.100	4.870	7.910	21.500	7.150	18.900	23.100
90039.0	CL	1676	12/3/96	47.0	3.060	1.840	-8.000	-9.000	5.880	1.480	4.920	8.550	2.900	15.400	13.000
93179.0	NAVAL SHIPYARDS O3 (x1)	1677	12/3/96	47.0	13.700	26.400	9.420	-9.000	60.900	28.000	30.900	83.800	29.500	96.800	75.600
90020.0	G DE LAPPE	1678	12/3/96	47.0	34.400	85.900	24.200	-9.000	183.000	82.700	84.600	246.000	77.200	247.000	152.000
93178.0	NAVAL SHIPYARDS O2 (x1)	1679	12/3/96	47.0	23.546	51.950	14.385	-9.000	108.875	49.119	51.488	149.414	45.615	104.357	123.501
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	0.685	0.288	0.241	-9.000	1.120	0.726	1.500	2.490	1.350	1.930	3.030
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47.0	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000

PCB CONGENER AND AROCLOR ANALYSIS OF SEDIMENTS (dry weight-ppb-ng/g)

STANUM	STATION	IDORG	DATE	LEG	PCB5	PCB8	PCB15	PCB18	PCB27	PCB28	PCB29	PCB31	PCB44	PCB49	PCB52
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	-8.000	0.969	-8.000	0.947	-8.000	1.200	-8.000	-8.000	1.520	2.370	4.380
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	-8.000	-8.000	-8.000	0.465	-8.000	-8.000	-8.000	-8.000	-8.000	0.872	1.510
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	-8.000	-8.000	1.450	1.390	0.199	2.360	-8.000	0.862	2.810	4.440	6.190
90039.0	CL	1676	12/3/96	47.0	-8.000	1.260	65.300	-8.000	-8.000	-8.000	-8.000	2.200	1.520	2.410	7.710
93179.0	NAVAL SHIPYARDS O3 (x1)	1677	12/3/96	47.0	1.820	5.190	12.200	8.980	2.650	7.300	-8.000	4.020	21.600	17.100	44.600
90020.0	G DE LAPPE	1678	12/3/96	47.0	3.750	20.200	18.700	13.700	2.400	12.200	-8.000	9.300	63.600	43.200	141.000
93178.0	NAVAL SHIPYARDS O2 (x1)	1679	12/3/96	47.0	2.523	15.030	13.411	9.918	1.955	6.820	0.000	5.586	38.058	31.818	89.920
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	2.890	7.210	-8.000	0.452	-8.000	0.511	-8.000	0.124	0.299	0.813	0.492
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47.0	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000	-9.000

SECTION IV

PCB and Aroclor Analysis of Sediments

PESTICIDES ANALYSIS OF SEDIMENTS (dry weight-ppb-ng/g); TBT ANALYSIS OF SEDIMENTS (dry weight-ppm-ug/g)

STANUM	STATION	IDORG	DATE	LEG	METADATA	SOWEIGHT	SOMOIST	ALDRIN	CCHLOR	TCHLOR	ACDEN	GCDEN
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	CHM47_56.TXT	20.04	56.19	-8.000	1.730	-8.000	-8.000	-9.000
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	CHM47_56.TXT	21.53	55.74	-8.000	1.640	1.260	0.205	-9.000
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	CHM47_56.TXT	23.40	62.31	-8.000	2.030	1.920	-8.000	-9.000
90039.0	CI.	1676	12/3/96	47.0	CHM47_56.TXT	15.86	43.12	-8.000	40.700	40.400	7.290	-9.000
93179.0	NAVAL SHIPYARDS O3 (x1)	1677	12/3/96	47.0	CHM47_56.TXT	15.19	62.60	-8.000	1.820	1.970	0.804	-9.000
90020.0	G DE LAPPE	1678	12/3/96	47.0	CHM47_56.TXT	15.16	64.70	-8.000	2.400	2.250	0.783	-9.000
93178.0	NAVAL SHIPYARDS O2 (x1)	1679	12/3/96	47.0	CHM47_56.TXT	14.99	52.70	-8.000	3.115	2.954	0.760	-9.000
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	CHM47_56.TXT	14.82	63.70	-8.000	-8.000	0.166	1.650	-9.000
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47.0	CHM47_56.TXT	-9.00	-9.00	-9.000	-9.000	-9.000	-9.000	-9.000

PESTICIDES ANALYSIS OF SEDIMENTS (dry weight-ppb-ng/g); TBT ANALYSIS OF SEDIMENTS (dry weight-ppm-ug/g)

STANUM	STATION	IDORG	DATE	LEG	CLPYR	DACTH	OPDDD	PPDDD	OPDDE	PPDDE	PPDDMS	PPDDMU	OPDDT	PPDDT
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	0.49	-8.000	-8.00	6.790	-8.00	6.04	-9.00	-8.00	-8.00	5.37
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	-8.00	-8.000	3.62	4.570	-8.00	3.80	-9.00	0.16	0.93	27.60
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	0.62	-8.000	3.10	7.960	-8.00	9.34	-9.00	0.47	1.03	5.70
90039.0	CL	1676	12/3/96	47.0	59.20	1.360	5.02	21.300	-8.00	13.90	-9.00	-8.00	1.86	66.70
93179.0	NAVAL SHIPYARDS O3 (x1)	1677	12/3/96	47.0	-8.00	-8.000	4.90	7.530	-8.00	7.46	-9.00	-8.00	5.31	5.39
90020.0	G DE LAPPE	1678	12/3/96	47.0	-8.00	-8.000	5.83	11.100	-8.00	8.16	-9.00	-8.00	12.70	3.53
93178.0	NAVAL SHIPYARDS O2 (x1)	1679	12/3/96	47.0	-8.00	-8.000	3.81	7.175	-8.00	10.68	-9.00	-8.00	6.88	3.54
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	-8.00	-8.000	0.65	0.630	-8.00	1.12	-9.00	-8.00	0.25	1.13
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47.0	-9.00	-9.000	-9.00	-9.000	-9.00	-9.00	-9.00	-9.00	-9.00	-9.00

PESTICIDES ANALYSIS OF SEDIMENTS (dry weight-ppb-ng/g); TBT ANALYSIS OF SEDIMENTS (dry weight-ppm-ug/g)

STANUM	STATION	IDORG	DATE	LEG	DICLB	DIELDRIN	ENDO_I	ENDO_II	ESO4	ENDRIN	ETHION	HCHA	HCHB	HCHG	HCHD
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	1.58	2.550	-8.000	10.40	5.79	-8.00	-8.00	-8.000	-8.00	-8.000	-8.000
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	-8.00	1.460	-8.000	5.77	2.13	-8.00	-8.00	0.077	-8.00	-8.000	-8.000
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	2.27	2.700	-8.000	8.86	6.27	-8.00	-8.00	0.549	-8.00	-8.000	-8.000
90039.0	CL	1676	12/3/96	47.0	-8.00	19.400	-8.000	13.80	4.43	-8.00	-8.00	-8.000	-8.00	8.240	-8.000
93179.0	NAVAL SHIPYARDS O3 (x1)	1677	12/3/96	47.0	2.47	4.170	-8.000	8.16	5.19	-8.00	-8.00	-8.000	0.11	0.492	-8.000
90020.0	G DE LAPPE	1678	12/3/96	47.0	2.41	7.700	-8.000	12.10	5.99	-8.00	-8.00	-8.000	-8.00	0.778	0.212
93178.0	NAVAL SHIPYARDS O2 (x1)	1679	12/3/96	47.0	0.90	4.767	-8.000	8.45	4.19	-8.00	-8.00	-8.000	-8.00	0.146	0.114
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	0.43	0.911	-8.000	0.18	0.38	-8.00	-8.00	-8.000	-8.00	0.197	-8.000
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47.0	-9.00	-9.000	-9.000	-9.00	-9.00	-9.00	-9.00	-9.000	-9.00	-9.000	-9.000

PESTICIDES ANALYSIS OF SEDIMENTS (dry weight-ppb-ng/g); TBT ANALYSIS OF SEDIMENTS (dry weight-ppm-ug/g)

STANUM	STATION	IDORG	DATE	LEG	HEPTACHLOR	HE	HCB	METHOXY	MIREX	CNONA	TNONA	OXAD	OCDAN	TOXAPH
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	-8.000	-8.000	0.144	-8.00	-8.000	1.830	1.720	-8.00	-8.000	-8.00
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	-8.000	-8.000	0.112	-8.00	-8.000	1.360	1.250	-8.00	-8.000	-8.00
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	-8.000	-8.000	0.151	-8.00	-8.000	2.320	1.500	-8.00	-8.000	-8.00
90039.0	CL	1676	12/3/96	47.0	-8.000	-8.000	0.630	-8.00	-8.000	15.100	36.900	11.20	-8.000	-8.00
93179.0	NAVAL SHIPYARDS O3 (x1)	1677	12/3/96	47.0	-8.000	-8.000	0.686	7.03	0.844	4.930	2.080	-8.00	-8.000	-8.00
90020.0	G DE LAPPE	1678	12/3/96	47.0	-8.000	-8.000	1.050	5.54	0.732	10.100	3.410	-8.00	-8.000	-8.00
93178.0	NAVAL SHIPYARDS O2 (x1)	1679	12/3/96	47.0	-8.000	-8.000	0.788	4.59	-8.000	6.293	2.911	-8.00	-8.000	-8.00
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	-8.000	-8.000	0.544	0.24	-8.000	0.315	0.184	-8.00	-8.000	-8.00
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47.0	-9.000	-9.000	-9.000	-9.00	-9.000	-9.000	-9.000	-9.00	-9.000	-9.00

PESTICIDES ANALYSIS OF SEDIMENTS (dry weight-ppb-ng/g); TBT ANALYSIS OF SEDIMENTS (dry weight-ppm-ug/g)

STANUM	STATION	IDORG	DATE	LEG	PESBATCH	TBT	TBTBATCH
90007.0	25 SWARTZ (NAVAL BASE/SY O10)	1673	12/3/96	47.0	97-325	0.0504	31.0
90008.0	27 SWARTZ (NAVAL BASE/SH O13)	1674	12/3/96	47.0	97-325	0.0574	31.0
90022.0	P SWARTZ (NAVAL BASE O12)	1675	12/3/96	47.0	97-325	0.1360	31.0
90039.0	CL	1676	12/3/96	47.0	97-325	0.0585	31.0
93179.0	NAVAL SHIPYARDS O3 (x1)	1677	12/3/96	47.0	97-329	0.3670	31.0
90020.0	G DE LAPPE	1678	12/3/96	47.0	97-329	0.6400	31.0
93178.0	NAVAL SHIPYARDS O2 (x1)	1679	12/3/96	47.0	97-329	0.1770	31.0
90013.0	37 SWARTZ (MARINA)	1680	12/3/96	47.0	97-329	-8.0000	31.0
95006.0	LOS PENASQUITOS (319)	1681	12/4/96	47.0	-9	-9.0000	-9.0